

MODEL 171 SYNTHESIZER/FUNCTION GENERATOR



WAVETEK

MODEL 171 SYNTHESIZER/FUNCTION GENERATOR

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Manual Revision 11/86

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SAFETY FIRST



PROTECT YOURSELF. Follow these precautions:

- Don't touch the outputs of the instrument or any exposed test wiring carrying the output signals. This instrument can generate hazardous voltages and currents.
- Don't bypass the power cord's ground lead with two-wire extension cords or plug adaptors.
- Don't disconnect the green and yellow safety-earth-ground wire that connects the ground lug of the power receptacle to the chassis ground terminal (marked with  or ).
- Don't hold your eyes extremely close to an rf output for a long time. The normally nonhazardous low-power rf energy generated by the instrument could possibly cause eye injury.
- Don't plug in the power cord until directed to by the installation instructions.
- Don't repair the instrument unless you are a qualified electronics technician and know how to work with hazardous voltages.
- Pay attention to the **WARNING** statements. They point out situations that can cause injury or death.
- Pay attention to the **CAUTION** statements. They point out situations that can cause equipment damage.

1

SECTION

INTRODUCTION

1.1 THE MODEL 171

The Wavetek Model 171 Synthesizer/Function Generator is a precision source of sine, triangle and square waveforms and dc voltage. The generator combines the precision frequency of a synthesizer with the versatility and operating convenience of a function generator. The two major modes of operation are synthesizer and function generator.

Function generator output frequency can be varied from 0.1 Hz to 2 MHz in seven ranges manually by dial and remotely by an applied voltage. In addition to this analog control of frequency, the Model 171 has a 4½ digit switch for synthesizer control of function generator frequency. The synthesizer gives precision (0.005%) frequency accuracy and stability (0.0001%/°C) from 1.000 Hz to 1.9999 MHz in six ranges. When the synthesizer is used to set the frequency, in addition to greater frequency accuracy and stability, the waveform purity is improved over that of the function generator alone.

Amplitude of the waveform is continuously variable from 10V peak-to-peak in a matching termination load (50Ω or 600Ω) down to 10 mV peak-to-peak in four ranges of attenuation (0, 20, 40, 60 dB). DC reference of the waveforms can be offset positively and negatively. The synthesizer can be locked to its own internal reference or to an external 1 MHz reference.

1.2 SPECIFICATIONS

The available waveforms, frequencies, amplitudes, operating modes, precision (accuracy) and purity (quality) are listed in the following paragraphs.

1.2.1 Versatility

Output Signals

Sine , triangle , square  and DC selectable. TTL pulse , 1 MHz reference pulse  and GCV signal proportional to output frequency are also available.

Control

Generator operates in continuous mode. Frequency is controlled manually by dial or digital switch, or externally thru VCG input voltage. Digital switch is operable between 0.1000 and 1.9999 settings and works with all frequency multipliers except X 1.

Frequency Range

0.1 Hz to 2 MHz in seven overlapping ranges.

Operating Frequency Ranges

FREQ MULT	Range	Digital Resolution
X 1	0.1 Hz to 2 Hz	N. A.
X 10	1 Hz to 20 Hz	0.001 Hz
X 100	10 Hz to 200 Hz	0.01 Hz
X 1K	100 Hz to 2 kHz	0.1 Hz
X 10K	1K Hz to 20 kHz	1.0 Hz
X 100K	10K Hz to 200 kHz	10 Hz
X 1M	100K kHz to 2 MHz	100 Hz

NOTE

Digital switch valid with all frequency multipliers except X 1 (first range). Frequency ratio of 1000:1 on dial, 20:1 on digital switch.

Main Output

, , ; variable to 20V p-p into open circuit and 10V p-p with matching load at either 50Ω OUT or 600Ω OUT. DC offset of waveform (or DC if selected) is adjustable to ±10 volts open circuit and ±5 volts into matching load. Waveform plus offset is limited to ±10V peak (open circuit).

Output waveforms can be attenuated from 0 dB to 80 dB: 60 dB in 20 dB steps plus a 20 dB vernier for continuous variation (20 dB vernier does not affect offset or DC output).

Optional output protection circuit of zeners and fuses protect both output and common sides from inadvertent connection to external voltage or ac line.

DC Offset and DC Output

DC offset of waveform and DC output are selectable and variable thru ±10V (±5V into matching load). Waveform plus offset is limited to ±10V peak (open circuit). Step attenuator attenuates dc level.

Generator Frequency TTL Output

TTL pulse has an approximately 50% duty cycle at generator frequency and can drive up to 20 TTL loads.

Optional TTL buffer circuit provides high power TTL compatible signal capable of driving load impedances as low as 50Ω.

GCV (Generator Controlled Voltage) Output

0 to +2V (nominal, open circuit) proportional to frequency of main generator. Output impedance 600 Ω .

VCG (Voltage Controlled Generator) Input

In function generator mode only, VCG voltage as well as dial settings select generator frequency. Frequency may be dc-programmed or ac-modulated by external 0 to 2V signal. Input impedance is 2 k Ω . VCG input can change generator output 1000:1 in function generator mode on all ranges (limited by a minimum VCG frequency of 0.1 Hz).

VCG Input Signal Bandwidth: 100 kHz.

VCG Slew Rate: 0.1 V/ μ s.

External Reference Input

1 MHz sine or square wave external reference clock signal of 1 Vrms to 10 Vrms. 5 k Ω input impedance.

Reference Output

TTL level 1 MHz pulse train output when in the synthesizer mode.

Optional TTL buffer circuit provides high power TTL compatible signal capable of driving load impedances as low as 50 Ω .

1.2.2 Operating Modes

Synthesizer

Operates as a synthesizer with function generator outputs locked to the synthesizer frequency. The frequency is determined by the frequency multiplier switch and the digital switch settings. The digital switch is operable from 0.1000 and 1.9999 on all ranges above the X 1 range.

Voltage Controlled Generator (VCG)

Operates as a conventional VCG. The frequency is controlled by the dial, multiplier switch and external VCG voltage on all ranges.

1.2.3 Frequency Precision

Synthesizer Operation

Accuracy: 0.005% of setting.

Stability: 1 ppm per degree C.

Internal Frequency Standard: 4 MHz crystal with an aging rate of 20 ppm per year.

Locking Time: Within 10% of final frequency in < 100 ms; within 0.01% of final frequency on X 1K, X 10K, X 100K and X 1M ranges in < 300 ms, X 100 in < 2s, X 10 in < 20s.

Dial/VCG Operation

Dial Accuracy: $\pm 3\%$ of full scale for 0.1 Hz to 200 kHz; $\pm 5\%$ of full scale for 200 kHz to 2 MHz.

Time Symmetry

$\pm 1\%$ on all ranges except X 1M range.

1.2.4 Amplitude Precision

Amplitude Change With Frequency (Sine)

Less than ± 0.1 dB on all ranges thru X 100K.

Less than ± 0.5 dB on X 1M range.

1.2.5 Waveform Purity

Harmonic Distortion

Less than 0.5% to 20 kHz (typically 0.2%).

Less than 1.0% to 200 kHz (typically 0.5%).

All harmonics 30 dB below fundamental on X 1M range.

Spurious Signals

Typically 70 dB below fundamental to 20 kHz and 40 dB below fundamental to 2 MHz (in synthesizer mode only).

Integrated Signal to Phase Noise

Typically 30 dB to 200 kHz measured over ± 15 kHz bandwidth excluding carrier ± 10 Hz (in synthesizer mode only).

Square Wave Rise and Fall Time

Less than 75 ns.

Triangle Linearity

Greater than 99% to 200 kHz.

TTL Pulse Rise and Fall Time

Less than 25 ns (15 ns typical).

1.2.6 Environmental

Specifications apply at 23°C $\pm 5^\circ$ C. Instrument will operate from 0°C to +50°C.

1.2.7 Mechanical

Dimensions

11 $\frac{1}{2}$ in./28.6 cm wide; 5 $\frac{1}{2}$ in./13.3 cm high; 10 $\frac{1}{2}$ in./27.3 cm deep.

Weight

8.5 lb/3.85 kg net; 12 lb/5.5 kg shipping.

1.2.8 Power

90 to 110V, 105 to 125V, 180 to 220V or 210 to 250V; 50 to 400 Hz; less than 20 watts.

NOTE

All specifications apply when frequency dial is between 0.1 and 2.0 or digital switch is between 0.1000 and 1.9999, amplitude is at 10V p-p and output is from the 50 Ω BNC into a 50 Ω load.

2

SECTION

INITIAL PREPARATION

2.1 UNPACKING INSPECTION

After carefully unpacking the instrument, inspect the external parts for damage to knobs, dials, indicators, surface areas, etc. If there is damage, file a claim with the carrier who transported the instrument. Retain the shipping container and packing material for use in case reshipment is required.

2.2 PREPARATION FOR USE

Before connecting the instrument to line power, be sure the rear panel 115/230V and HI/LO switches are set to the value nearest the line voltage and that the fuse is correct for the switch setting. Be sure that the plug on the power cord is the proper mate for the line receptacle.

AC Line Voltage	Switch A	Switch B	Fuse (SB)
90 - 110	115	LO	3/8 amp
105 - 125	115	HI	3/8 amp
180 - 220	230	LO	3/16 amp
210 - 250	230	HI	3/16 amp

2.3 ELECTRICAL ACCEPTANCE CHECK

This checkout procedure verifies the generator operation. If a malfunction is found, refer to the Warranty in the front of the manual. An oscilloscope, counter, three short lengths of 50Ω coax cable, a 50Ω feedthru load and a 0 to ±2V

voltage source are required (figure 2-1). Circled numbers index controls and connectors to figure 3-1.

1. Preset the generator front panel controls as follows:

Control	Position
Frequency Dial ①	1.0
FREQ MULT	X 1K
Digital Switch ④	1.9999
DC OFFSET	OFF
Waveform Selector ⑥	~
AMPLITUDE	Full cw
ATTENUATION	0
Dial/Digital Switch ②	Toward Dial

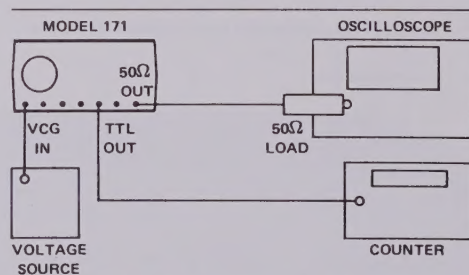


Figure 2-1. Performance Checkout Setup

Table 2-1. Performance Checkout

Step	Control	Position/Operation	Observe
Function			
1	Adjust the oscilloscope for several cycles of sine wave.		
2	Waveform Selector	~ , ⊏ , DC, ~	Waveform changes from ~ to ~ to ⊏ to a 0V dc level then ~ .
Amplitude			
1	AMPLITUDE	Ccw to 12 o'clock	Waveform amplitude reduces.

Table 2-1. Performance Checkout (Continued)

Step	Control	Position/Operation	Observe
2	DC OFFSET	9 o'clock, then slowly to full cw (return to OFF)	Waveform offset negatively, then positively (clipping may occur).
3	ATTENUATION	20, 40, 60 (return to 0)	Waveform amplitude decreases with each step.
Outputs			
1	Remove 50 Ω load and reconnect cable. Remove the 50 Ω OUT connection and place it on the 600 Ω OUT BNC.		Unloaded 50 Ω OUT and 600 Ω OUT are identical.
2	Remove the 600 Ω OUT connection and place it on the TTL OUT.		Square pulse at 1 kHz.
3	Remove the TTL OUT connection and place it on the REF OUT. Flip dial/digital switch selector to digital switch side.		1 MHz pulse.
4	Remove the REF OUT connection and place it on the GCV OUT.		2 Vdc level.
5	Flip dial/digital switch selector to dial side.		1 Vdc level.
Frequency			
1	Remove GCV OUT connection and place on 50 Ω OUT.		
2	FREQ MULT	Use each multiplier X 1 thru X 1M (return to X 1).	Observe an increase in frequency while stepping from X 1 to X 1M.
3	Dial	Vary from 2.0 to .2 (return to .2).	Observe a corresponding change in frequency.
4	Connect a 0 to ± 2 V source to the VCG IN BNC. Vary the voltage positively.		Observe a change in frequency proportional to the change in VCG voltage.
5	Dial	2.0	
6	Voltage Source	Vary the voltage negatively.	Observe a change in frequency proportional to the VCG voltage.
7	Disconnect the voltage source.		
8	Dial/Digital Switch Selector	Switch toward the digital switch.	1.9999 kHz.
9	Digital Switch	Set each position of the digital switch.	Observe counter readout corresponding to set of digital switch.

3

SECTION

OPERATION

3.1 CONTROLS AND CONNECTORS

The generator front panel controls and connections shown in figure 3-1 are keyed by circled numbers to the following descriptions.

1 Frequency Dial

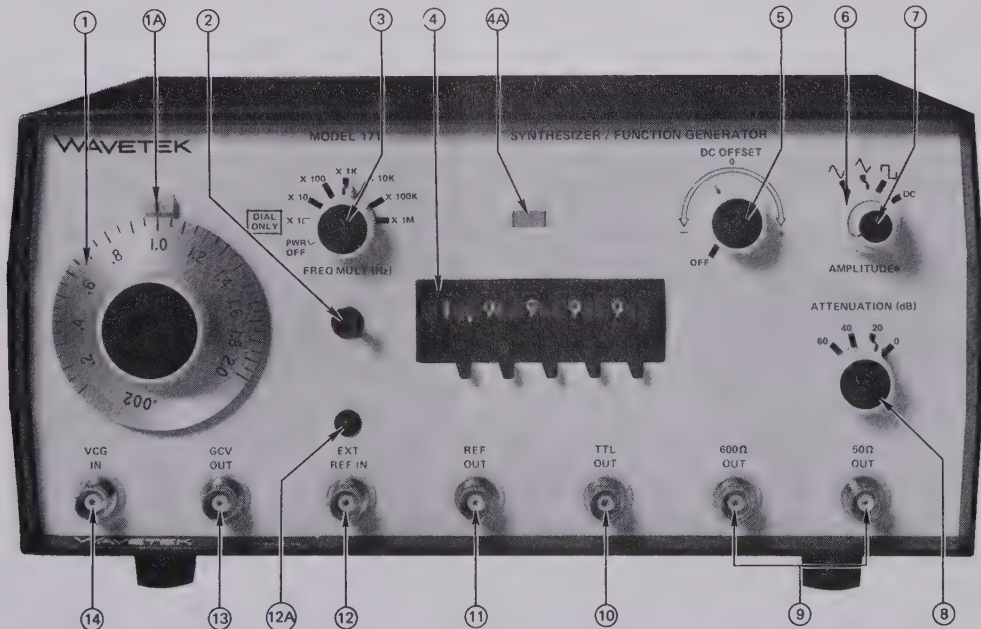
When the frequency dial is selected by the dial/digital switch selector (2) the index (1A) lights and the frequency output is determined by the dial, FREQ MULT (3) and VCG (14) voltage.

2 Dial/Digital Switch Selector

Places the instrument in either function generator (dial controlled) or synthesizer (digital switch controlled) mode. Respective dial index (1A) or digital switch index (4A) lights to indicate operation mode.

3 FREQ MULT (Hz)

Power is turned on when frequency range is selected at FREQ MULT. The multipliers are for the dial (1) and digital switch (4) readings and the VCG (14) voltage.



④ Digital Switch

When the digital switch is selected by the dial/digital switch selector ② the index ④A lights and the frequency output is determined by the digital switch and the FREQ MULT.

⑤ DC OFFSET

Rotating DC OFFSET clockwise past 12 o'clock offsets dc output or dc center reference of the output waveform positive; when counterclockwise, negative. When OFF, the dc output is signal ground or the output waveform is balanced around signal ground (0V in figure 3-2).

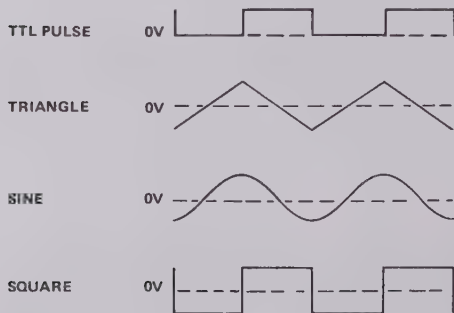


Figure 3-2. Output Waveforms

⑥ $\sim$, $\wedge$, $\sqcap$ and DC (Waveforms)

Sine $\sim$, triangle $\wedge$ and square $\sqcap$ waveforms are selected by the larger of the two concentric controls; the DC position provides a dc voltage output controlled by DC OFFSET. Outputs appear at 50 Ω OUT and 600 Ω OUT.

⑦ AMPLITUDE

Rotating AMPLITUDE fully clockwise provides maximum peak-to-peak output at 50 Ω OUT and 600 Ω OUT; rotating counterclockwise gives up to 20 dB attenuation. Also see ATTENUATION ⑧. AMPLITUDE does not affect dc offset or dc output.

⑧ ATTENUATION

With a 600 Ω load on the 600 Ω OUT connector or a 50 Ω load on the 50 Ω OUT connector, output voltage for each attenuation is:

Attenuation	Amplitude Control	
	Full cw	Full ccw
0	10V p-p	1V p-p
20	1V p-p	100 mV p-p
40	100 mV p-p	10 mV p-p
60	10 mV p-p	(Not specified)

⑨ 600 Ω OUT and 50 Ω OUT Connectors

600 Ω OUT and 50 Ω OUT provide variable frequency and amplitude $\sim$, $\wedge$, $\sqcap$ and DC. Maximum signal amplitude is 10V p-p with matching loads (20V p-p into open circuit).

⑩ TTL OUT Connector

A fixed amplitude Transistor-Transistor Logic (TTL) square pulse train of the output frequency. (TTL levels are 0V to 0.4V for a logic low and 2.4V to 5V for a logic high.) The output can drive up to 20 TTL loads. The pulse train can also be used as a synchronizing reference to 50 Ω OUT and 600 Ω OUT. Phase of output waveforms relative to the TTL pulse is shown in figure 3-1.

⑪ REF OUT Connector

A fixed amplitude Transistor-Transistor Logic (TTL) pulse train of 1 MHz whose origin is an internal clock oscillator or, if indicator ⑫A is lit, the external reference signal of 1 MHz.

⑫ EXT REF IN Connector

Input for a 1 MHz sine or square wave external reference clock signal. The signal must be at least 1 Vrms. Synthesizer frequencies are referenced to this signal when indicator ⑫A is lit.

⑬ GCV OUT Connector

DC excursions at the Generator Controlled Voltage output (GCV OUT) of 0V to about 2V proportionally represents frequency within the range indicated by FREQ MULT.

⑭ VCG IN Connector

DC excursions at the Voltage Controlled Generator input (VCG IN) proportionally control frequency within the range determined by FREQ MULT. Positive voltage increases the frequency set by the dial ①; negative voltage decreases the frequency. Use in function generator mode only.

3.2 OPERATION

Operation is described as function generator operation and synthesizer operation. The generator is ready to operate as soon as a frequency multiplier is selected.

3.2.1 Signal Termination

Proper signal termination, or loading, of the generator connectors is necessary for its specified operation. For example, the proper termination of the 50Ω OUT connector is shown in figure 3-3. Placing the 50 ohm terminator, or 50 ohm resistance, in parallel with a higher impedance, matches the receiving instrument input impedance to the generator output impedance, thereby minimizing signal reflection or power loss on the line due to impedance mismatch.

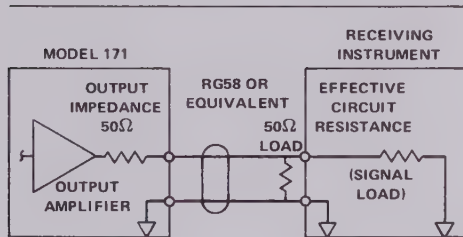


Figure 3-3. Signal Termination

The input and output impedances of the generator connectors are listed below:

Connector	Impedance
50Ω OUT	50Ω
600Ω OUT	600Ω
TTL OUT	*
REF OUT	*
VCG IN	2 kΩ
GCV OUT	600Ω
REF IN	5 kΩ

*The TTL OUT connector can drive up to 20 Transistor-Transistor Logic (TTL) loads (low level between 0V and 0.4V, and high level between 2.4V and 5V). REF OUT can drive up to 3 TTL loads. Addition of the TTL buffer option gives these outputs the capability of driving a 50Ω load.

3.2.2 Manual Function Generator Operation

For basic operation, select the waveform frequency and amplitude. The following steps demonstrate manual control of the function generator. (Circled numbers are keys to figure 3-1.)

Step	Control/Connector	Setting
1	50Ω OUT or 600Ω OUT	Connect circuit to either output (refer to paragraph 3.2.1).
2	Dial/Digital Switch Selector ②	Set toward the dial.
3	FREQ MULT	Set to desired range of frequency.
4	Frequency Dial ①	Set to desired frequency within the range.
5	Waveform Selector ⑥	Set to desired waveform.
6	DC OFFSET	Set as desired. Limit waveform amplitude to prevent clipping (see figure 3-4).
7	AMPLITUDE and ATTENUATION	Select for desired amplitude.

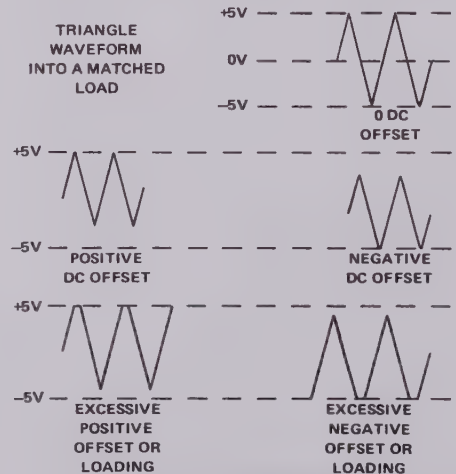


Figure 3-4. DC OFFSET Control

3.2.3 Voltage Controlled Function Generator Operation

Operation as a voltage controlled function generator (VCG) is as for a manually controlled function generator, only the frequency within particular ranges is additionally controlled with dc levels ($\pm 2V$ excursions) injected at the VCG IN connector. Perform the steps given in paragraph 3.2.2, only set the frequency dial to determine a reference from which the frequency is to be voltage controlled.

1. For frequency control with positive dc inputs at VCG IN, set the dial for a lower frequency limit.
2. For frequency control with negative dc inputs at VCG IN, set the dial for an upper frequency limit.
3. For modulation with an ac input at VCG IN, set the dial at the desired center frequency. Do not exceed the maximum dynamic range of the selected frequency range.

Figure 3-5 is a nomograph with examples of dial and voltage effects. Example 1 shows that with 0V VCG input, frequency is as determined by the main dial setting, 1.0 in this example. Example 2 shows that with a positive VCG input, output frequency is increased. Example 3 shows that with a negative VCG input, output frequency is decreased. (Note that the Output Frequency Factor column value must be multiplied by a frequency range multiplier to give the actual output frequency.)

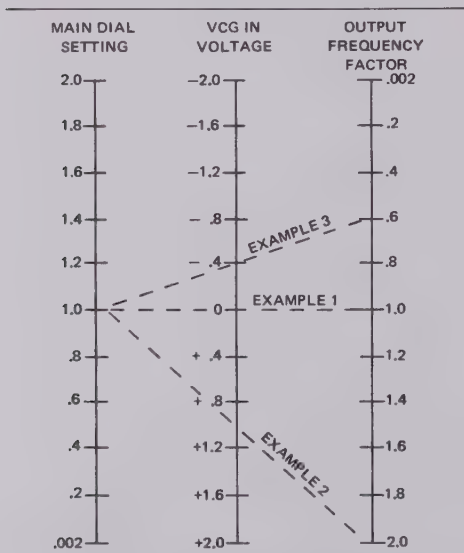


Figure 3-5. VCG Voltage-to-Frequency Nomograph

NOTE

Nonlinear operation results when the VCG input voltage is excessive; that is, when the attempted generator frequency exceeds the range setting (2 times the multiplier setting) or in the other direction, 1/1000th of the range setting.

The up to 1000:1 VCG sweep of the generator frequencies available in each range results from a 2V excursion at the

VCG IN connector. With the frequency dial set to 2.0, excursions between -2V and 0V at VCG IN provide the up to 1000:1 frequency sweep. With the dial set to .002, excursions between 0V and +2V at VCG IN provide the up to 1000:1 sweep within the set frequency range.

3.2.4 Synthesizer Operation

For synthesizer operation, select the waveform, frequency and amplitude. The following steps demonstrate synthesizer control. (Circled numbers are keys to figure 3-1.)

Step	Control/Connector	Setting
1	50Ω OUT or 600Ω OUT	Connect the circuit to either output (refer to paragraph 3.2.1).
2	Dial/Digital Switch Selector ②	Set toward digital switch.
3	FREQ MULT	Set to desired range of frequency.
4	Digital Switch ④	Set to desired frequency within the range.
5	Waveform Selector ⑥	Set to desired waveform.
6	DC OFFSET	Set as desired. Limit waveform amplitude to prevent clipping (see figure 3-4).
7	AMPLITUDE and ATTENUATION	Select desired amplitude.

Synthesizer frequencies are normally referenced to an internal crystal oscillator. However, an external 1 MHz sine or square wave reference signal can be applied at REF IN; the indicator ⑬A will light, indicating a proper external reference in use.

3.2.5 Monitoring the Synthesizer/Function Generator

Besides the 50Ω OUT and 600Ω OUT main generator outputs, the GCV OUT connector supplies a voltage proportional to the generator frequency, the TTL OUT connector supplies a TTL compatible pulse train at the generator frequency, and the REF OUT supplies a TTL compatible 1MHz pulse train.

The GCV OUT signal is used to drive the frequency axis of an X-Y recorder or oscilloscope; the generator frequency TTL OUT signal is used to synchronize other devices to the generator or to drive TTL level inputs, and the REF OUT signal is used to reference other 171's to a master crystal oscillator.

1. For frequency control with positive dc inputs at VCG IN, set the dial for a lower frequency limit.
2. For frequency control with negative dc inputs at VCG IN, set the dial for an upper frequency limit.
3. For modulation with an ac input at VCG IN, set the dial at the desired center frequency. Do not exceed the maximum dynamic range of the selected frequency range.

Figure 3-5 is a nomograph with examples of dial and voltage effects. Example 1 shows that with 0V VCG input, frequency is as determined by the main dial setting, 1.0 in this example. Example 2 shows that with a positive VCG input, output frequency is increased. Example 3 shows that with a negative VCG input, output frequency is decreased. (Note that the Output Frequency Factor column value must be multiplied by a frequency range multiplier to give the actual output frequency.)

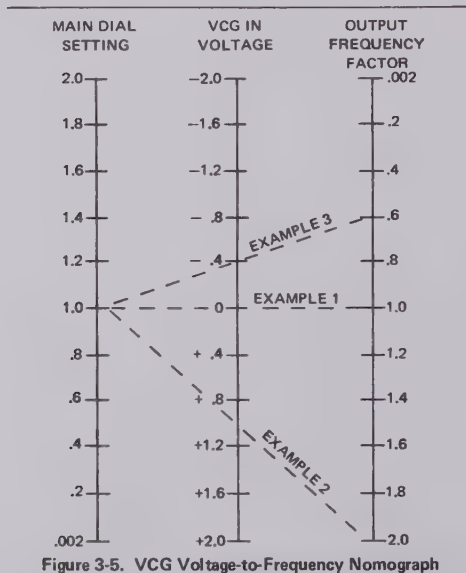


Figure 3-5. VCG Voltage-to-Frequency Nomograph

NOTE

Nonlinear operation results when the VCG input voltage is excessive; that is, when the attempted generator frequency exceeds the range setting (2 times the multiplier setting) or in the other direction, 1/1000th of the range setting.

The up to 1000:1 VCG sweep of the generator frequencies available in each range results from a 2V excursion at the

VCG IN connector. With the frequency dial set to 2.0, excursions between -2V and 0V at VCG IN provide the up to 1000:1 frequency sweep. With the dial set to .002, excursions between 0V and +2V at VCG IN provide the up to 1000:1 sweep within the set frequency range.

3.2.4 Synthesizer Operation

For synthesizer operation, select the waveform, frequency and amplitude. The following steps demonstrate synthesizer control. (Circled numbers are keys to figure 3-1.)

Step	Control/Connector	Setting
1	50Ω OUT or 600Ω OUT	Connect the circuit to either output (refer to paragraph 3.2.1).
2	Dial/Digital Switch Selector ②	Set toward digital switch.
3	FREQ MULT	Set to desired range of frequency.
4	Digital Switch ④	Set to desired frequency within the range.
5	Waveform Selector ⑥	Set to desired waveform.
6	DC OFFSET	Set as desired. Limit waveform amplitude to prevent clipping (see figure 3-4).
7	AMPLITUDE and ATTENUATION	Select desired amplitude.

Synthesizer frequencies are normally referenced to an internal crystal oscillator. However, an external 1 MHz sine or square wave reference signal can be applied at REF IN; the indicator ⑬A will light, indicating a proper external reference in use.

3.2.5 Monitoring the Synthesizer/Function Generator

Besides the 50Ω OUT and 600Ω OUT main generator outputs, the GCV OUT connector supplies a voltage proportional to the generator frequency, the TTL OUT connector supplies a TTL compatible pulse train at the generator frequency, and the REF OUT supplies a TTL compatible 1MHz pulse train.

The GCV OUT signal is used to drive the frequency axis of an X-Y recorder or oscilloscope; the generator frequency TTL OUT signal is used to synchronize other devices to the generator or to drive TTL level inputs, and the REF OUT signal is used to reference other 171's to a master crystal oscillator.

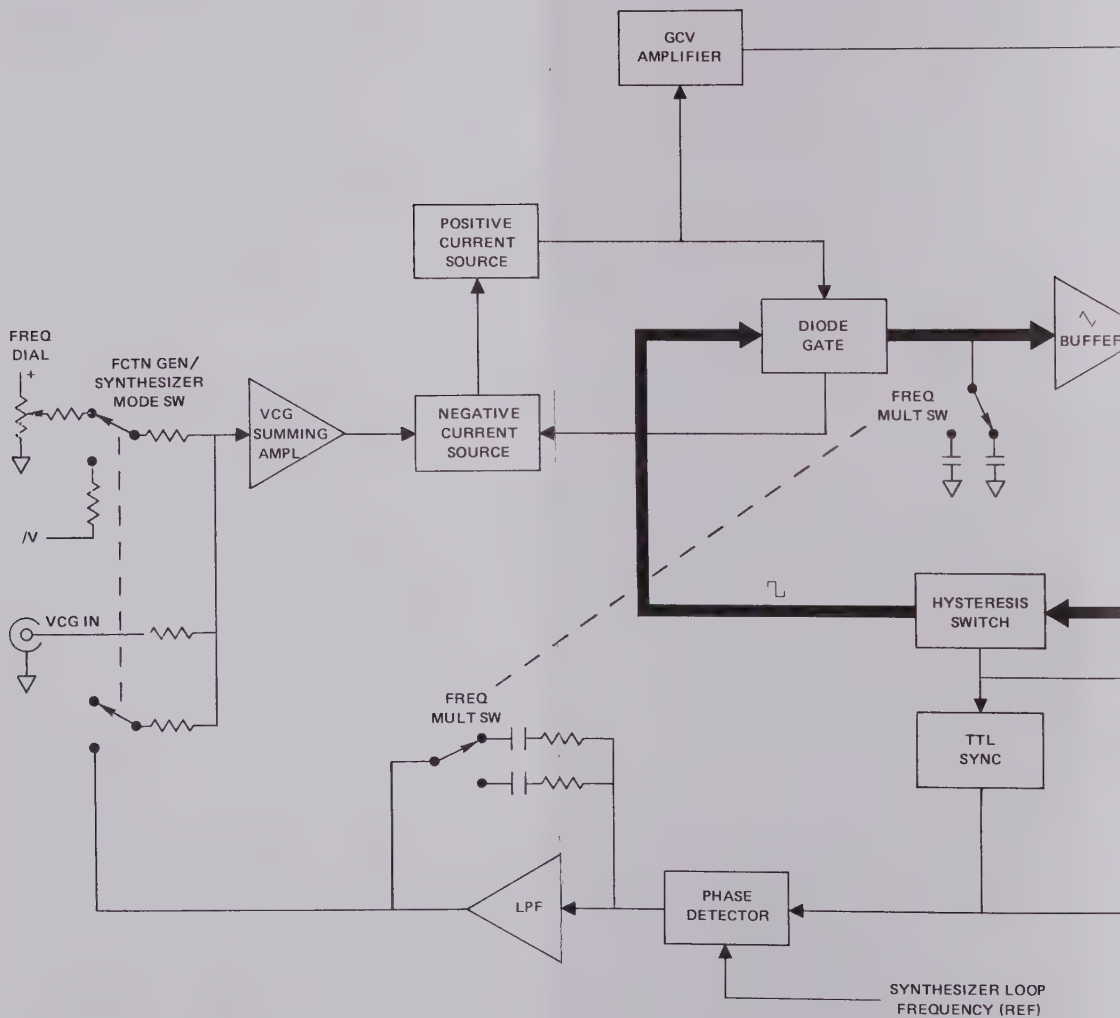
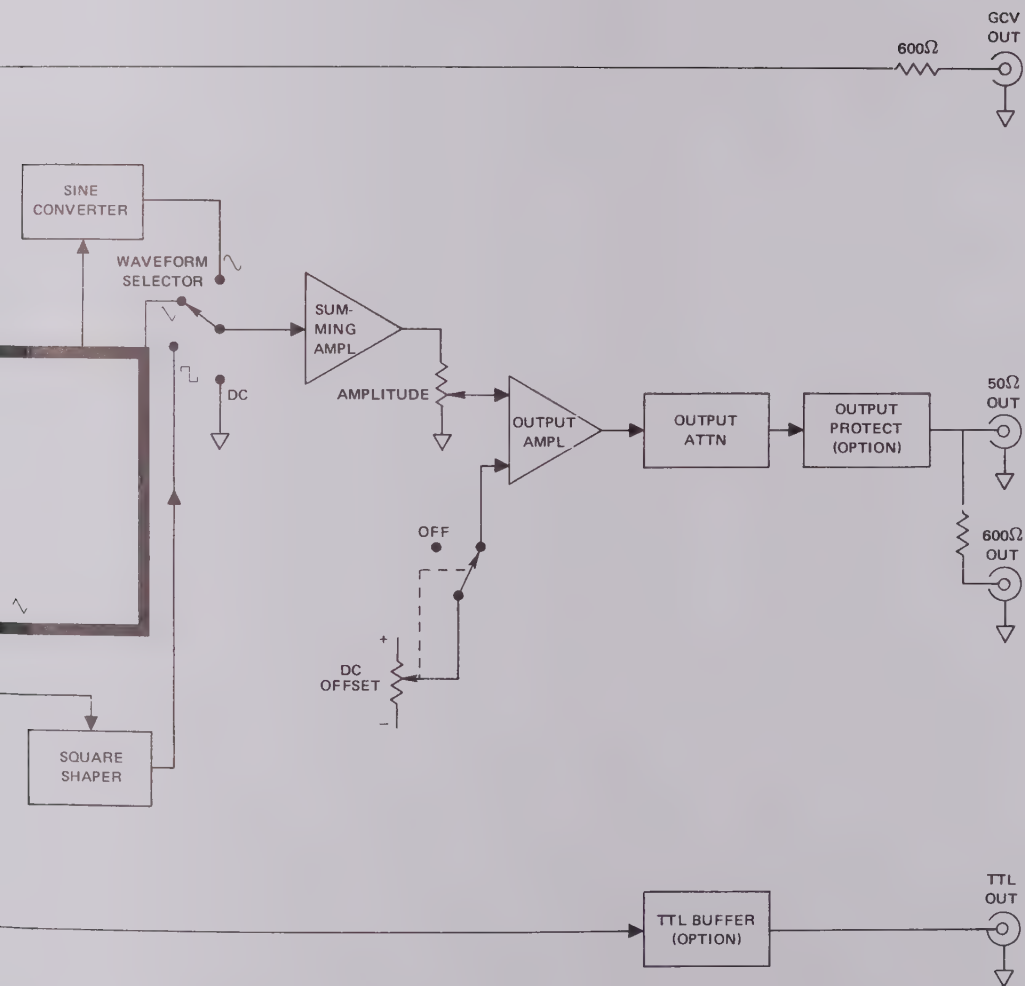


Figure 4-1. Function Generator Block Diagram



4

SECTION

CIRCUIT DESCRIPTION

4.1 FUNCTION GENERATOR

As shown in figure 4-1, the VCG summing amplifier sums the currents from the frequency dial and VCG input connector in function generator mode or from the low pass filter output and the frequency-to-voltage (F/V) converter output in synthesizer mode. The low pass filter is part of the generator frequency phase lock loop which provides a feedback current that corrects generator frequency to be exactly that of the synthesizer loop output. (Phase lock loop operation is described in paragraph 4.5.) The F/V input is also from the synthesizer loop and provides a gross correction to increase the response time of the generator to changes in synthesizer frequency programming.

The VCG summing amplifier is a noninverting buffer whose output current is used to control a positive current source and a negative current source. The currents from the two current sources are equal and opposite polarity and the magnitudes are directly proportional to the current of the VCG summing amplifier output. The diode gate, which is controlled by the hysteresis switch, is used to switch the positive current or the negative current to the integrating capacitor selected by the frequency multiplier. If the positive current is switched into the capacitor, the voltage across the capacitor will increase linearly to generate the positive slope of the triangle wave. If the current is negative, the voltage across the capacitor will decrease linearly to produce the negative slope.

The triangle buffer amplifier is a unity gain amplifier whose output is fed to the hysteresis switch as well as to the sine converter. The hysteresis switch has two voltage limit points (+1.25V and -1.25V). (See figure 4-2.)

During the time the output voltage of the triangle buffer amplifier is increasing, the output voltage of the hysteresis switch is positive, but when the output voltage of the triangle amplifier reaches +1.25V, it triggers the hysteresis switch causing the switch output to become negative. Once the control voltage into the diode gate becomes negative, it will switch the positive current out and switch the negative current in to the integrating capacitor, starting a linear decrease of the voltage across the capacitor. When the decreasing voltage reaches -1.25V, the output of the hysteresis switch will switch back to positive, reversing the process. This action

generates the triangle waveform as shown in figure 4-2. Since the output of the hysteresis switch is a square wave, the result is simultaneous generation of a square wave and triangle wave at the same frequency.

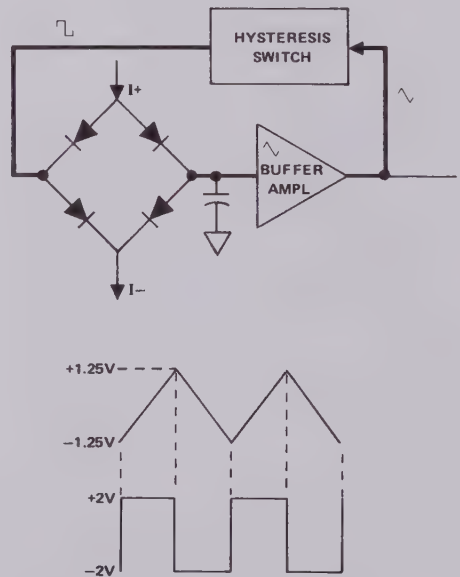


Figure 4-2. Generator Loop and Waveforms

4.2 FREQUENCY CONTROL

The output frequency is determined by the magnitude of the integrating capacitor selected by the frequency multiplier and the magnitude of the positive and negative current sources (figure 4-1). Since the current magnitudes are linearly proportional to the sum of the VCG current, the output frequency will also be linearly proportional to the current sum.

By using current division, the magnitude of the capacitor is effectively increased, allowing the generation of lower fre-

quencies. Figure 4-3 is the simplified diagram showing current divider operation. By reducing integration current precisely by a factor of 10 while holding triangle wave amplitude constant, it is possible to extend the lower frequency range by a factor of 10 with fixed capacitance C . Since points A and B are at the equipotential points, constant current output I can be divided by resistance ratio of R and $9R$. Then, integration current of capacitor C is reduced to $0.1 I$. The lower current extends the frequency range of the function generator by a factor of 10. The same theory is applied to extend the frequency range by a factor of 100.

4.3 WAVEFORM OUTPUT

The inverted output of the hysteresis switch is fed to the TTL buffer amplifier and also the square wave shaper (figure 4-1). The square wave shaper consists of a shaping circuit which limits the output swing to ± 1.25 volts.

The output signal from the triangle buffer amplifier is applied to the sine converter, which uses a diode-resistor network with nonlinear sections to shape a sine wave.

The sine, triangle or square waveform is fed to the summing amplifier through the waveform selector switch. The output of summing amplifier is fed through the amplitude control to the output amplifier. The output amplifier is an inverting amplifier whose output is capable of driving 10V p-p into selected load impedance.

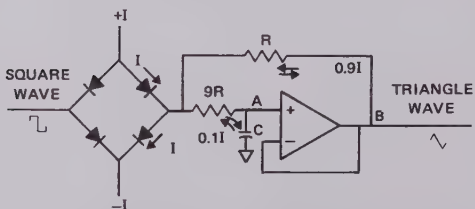


Figure 4-3. Current Divider

4.4 OUTPUT ATTENUATOR AND PROTECTION CIRCUIT

The signal from the output amplifier is routed through an attenuation network for step attenuation. If the optional protection circuit is installed, the instrument output circuits are protected from input voltages by a zener and fuse network protecting both the signal and ground sides of the output BNC's. Two source impedances, 50 and 600 ohms, are provided at the outputs.

4.5 PHASE LOCK LOOP

A phase lock loop is shown in figure 4-4. The phase detector output is proportional to the difference in frequency between the two inputs. This difference signal is used to control a voltage controlled oscillator (VCO). The VCO output signal is fed back to the phase detector, where the VCO frequency is compared to the reference input to the detector. This reference input is, for example, a constant 1.0000 kHz signal. The loop becomes stable when the VCO frequency equals the reference frequency, at which time the detector difference signal becomes zero.

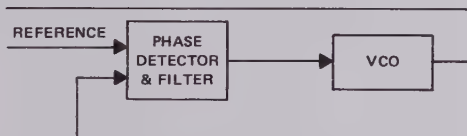


Figure 4-4. Phase Lock Loop

4.6 SYNTHESIZER LOOP

The reference frequency for the synthesizer is provided by an internal 4 MHz crystal or by an external 1 MHz signal (figure 4-5). Either source provides a 1 MHz REF OUT signal which is also reduced to 1.0000 kHz for the reference input to the phase detector.

The phase detector difference signal is a pulse train whose spacing and magnitude reflect the phase difference. The low pass filter (LPF) shown in the synthesizer loop converts this pulse train to a voltage inversely proportional to the phase difference. Noise, particularly 1 kHz, is filtered by the 400 Hz cutoff filter. The dc voltage controls the VCO frequency using a varactor diode as the tunable element.

The programmable divider in the loop ($\div P$) is controlled by the front panel digital switch; for any division of frequency programmed, the loop rapidly drives the phase detector's other input to 1.0000 kHz. For example, if divide by 16000 is programmed, an imbalance is initially set up and the VCO frequency is increased such that $f_{VCO} \div 16000 = 1.0000$ kHz, which returns the loop to a stable condition. (The VCO frequency (f_{VCO}) was 16 MHz.)

The VCO has a tunable range of only 3:1, hence the VCO range has been limited to 8 to 20 MHz. When below 8 MHz from the VCO would be required, a prescaler is placed in the loop, which is also controlled by the digital switch, to keep the division factor large, which in turn keeps VCO frequency greater than 8 MHz. The prescaler output is a 1M to 20 MHz signal. The output of the prescaler is divided by 10 before the frequency ranging circuit to give the frequency equivalent to the digital switch programmed value. The resulting fre-

quency is divided by a multiple of 10, as controlled by the FREQ MULT range switch, and fed to the function generator phase lock loop (figure 4-1).

A 10k to 200 kHz output is used to create the F/V signal which gives rapid function generator response to frequency changes. A one-shot changes the signal to fixed width pulses whose spacing is frequency dependent. These are converted

to a frequency dependent voltage level at the F/V converter output.

One pole of the function generator/synthesizer mode switch furnishes the ground signal CLK KILL. CLK KILL stops synthesizer loop activity when the instrument is in function generator mode or set on X 1, a dial-only range. Lamps indicating mode are also controlled by this CLK KILL.

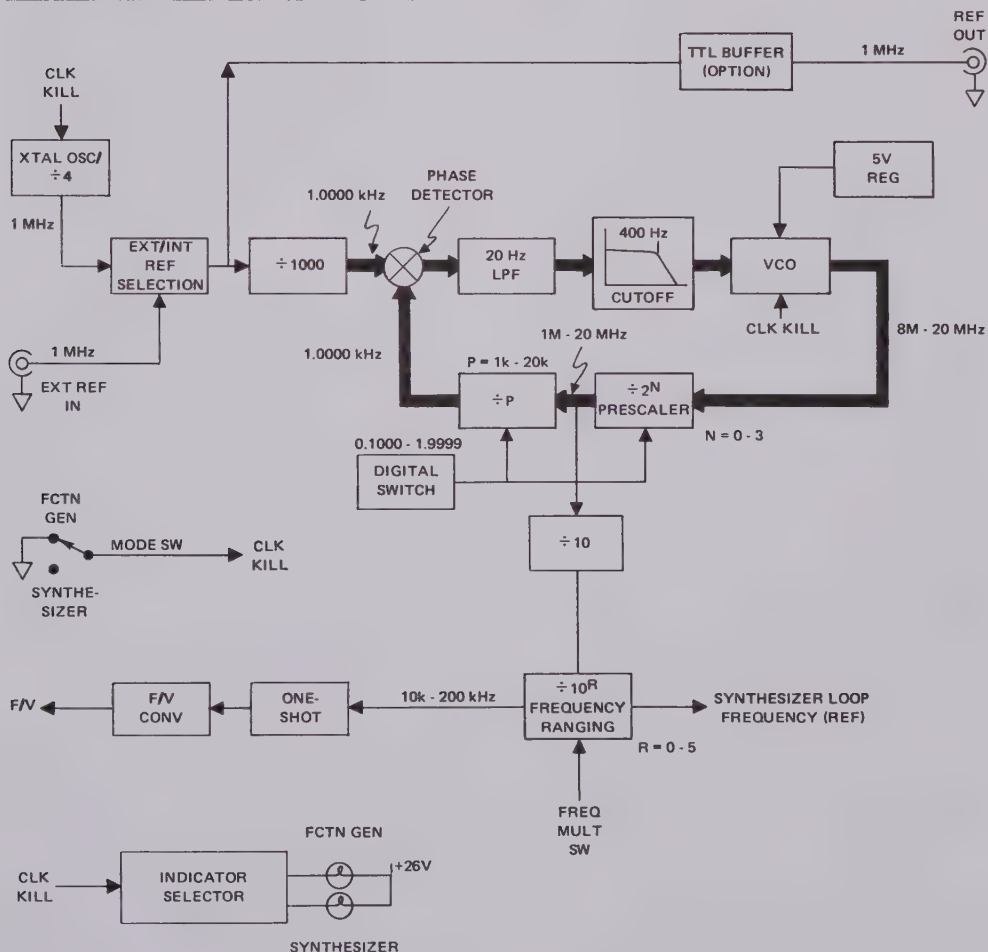


Figure 4-5. Synthesizer Phase Lock Loop

5.1 FACTORY REPAIR

Wavetek maintains a factory repair department for those customers not possessing the necessary personnel or test equipment to maintain the instrument. If an instrument is returned to the factory for calibration or repair, a detailed description of the specific problem should be attached to minimize turnaround time.

5.2 REQUIRED TEST EQUIPMENT

DVM (3½ digit)

Distortion Analyzer (1% F.S.) HP334A

Oscilloscope (≥40 MHz bandwidth, × 10 horizontal magnification, dc triggering to 1 Hz)

BNC Termination (50Ω ≤ 1%, ≥ 1W)

Frequency Counter (6 digits, time base accuracy ≥ 50 ppm)

Low Frequency Spectrum Analyzer HP3580A

5.3 REMOVING GENERATOR COVER

For main board access, remove the four screws in the lower cover, place the instrument on its feet and lift off the top cover. For later access to the synthesizer board, remove the four screws from the inside corners of the lower board that attach it via standoffs to the lower cover. Do not remove the lower cover unless necessary, because it supports front and rear panels.

5.4 CALIBRATION

After referring to the following preliminary data, perform calibration, as necessary, per table 5-1. If performing partial calibration, check previous settings and adjustments for applicability.

NOTE

The completion of the calibration procedure returns the instrument to correct alignment.

CALIBRATION LIMITS AND TOLERANCES ARE NOT INSTRUMENT SPECIFICATIONS

Instrument specifications are given in Section 1 of this manual.

1. Unless otherwise noted, all measurements made at the 50Ω OUT connector should be terminated into a 50Ω (≤ 1%, 1W) load.
2. Before connecting the unit to an ac source, check the ac line circuit to make sure the 115/230 volt switch is set at the correct position (see paragraph 2.2).
3. Start the calibration by setting the front panel switches as follows:

Dial	2.0
FREQ MULT	× 1K
Mode (toggle switch)	Toward Dial
Digital Switch	0.1000
DC OFFSET	OFF
Function	DC
AMPLITUDE	ccw
ATTENUATION	0
4. Allow the unit to warm up at least 30 minutes for final calibration. Start the calibration on main board. All test points are located on the main board.

Table 5-1. Calibration Chart

Step	Check	Tester	Cal Points	Control Settings	Adjust	Desired Results	Remarks
1	Power supply regulation	DVM	TP2 (TP1 ground)		R20	+15 ± 0.01V	Main board
2			TP3 (–15V)			–15 ± 0.05V	
3	Output dc balance	Scope or DVM	50Ω OUT		R116	0 ± 0.01 Vdc	
4				AMPLITUDE: cw	R141		

Table 5-1. Calibration Chart (Continued)

Step	Check	Tester	Cal Points	Control Settings	Adjust	Desired Results	Remarks
5	Distortion	Distortion analyzer (50Ω terminated)	50Ω OUT	Function: 	R72 R93	Minimum distortion	
6	VCG null	Scope		FREQ MULT: X 100K Function:  Dial: full cw Scope vert: 2V/div Scope horiz: .5 ms/div	R40	Minimum frequency shift	Adjust generator dial to display one cycle on scope. Alternately short and open VCG IN BNC while adjusting R40.
7	Horizontal symmetry			Scope Horiz: X 10 on	R42	Maximum symmetry	Alternately switch scope triggering from positive to negative slope while adjusting R42.
8				Dial: 01 FREQ MULT: X 10 Scope sweep: 0.1s/div, dc triggering	R60		
9	Frequency accuracy	Counter		Dial: 2.0 FREQ MULT: X 1 thru X 10K	R32	Best frequency accuracy over X 1 thru X 10K	
10				FREQ MULT: X 1M Function:  Dial: 2.0	C37	2.020 MHz	
11				Function:  ,  , 		Best frequency tracking on X 1M range	
12	Internal reference		REF OUT	Mode toggle switch: towards digital switch	C1	1 MHz ±20 Hz	C1 is on synthesizer board.
13	F/V balance	Scope or DVM	TP5 (TP1 common)	FREQ MULT: X 10K Digital Switch: 0.1000	R31	0 ±0.1 Vdc	
14	F/V gain			Digital Switch: 0.9999	R28	+1 Vdc approx	
15				Digital Switch: 1.9999		−1 Vdc approx	
16	Frequency range	Counter	50Ω OUT	FREQ MULT: X 1M thru X 10 Function: 		Reading ±0.005% each setting	

Table 5-1. Calibration Chart (Continued)

Step	Check	Tester	Cal Points	Control Settings	Adjust	Desired Results	Remarks
17	Frequency bits	Counter	50 Ω OUT	FREQ MULT: X 10K Digital Switch: 0.1111 thru 0.9999		Proper reading on counter	
18	Spectral purity	Spectrum Analyzer		Function: $\wedge$ Digital Switch: 1.9999		Spurious signals below -70 dB. Noise floor below -60 dB	Set 3580A controls for a 3 Hz bandwidth with minimum smoothing; scanning 20 Hz/div at 5s/div. Check that average of noise floor at $f_0 + 3$ Hz is below -60 dBc and that no line related spurs are above -70 dBc. Keep power lines away from analyzer input.

6

SECTION

TROUBLESHOOTING

6.1 FACTORY REPAIR

Wavetek maintains a factory repair department for those customers not possessing the necessary personnel or test equipment to maintain the instrument. If an instrument is returned to the factory for calibration or repair, a detailed description of the specific problem should be attached to minimize turnaround time.

6.2 TROUBLESHOOTING CHART

Troubleshooting charts are given in figures 6-1 thru 6-4. The charts do not cover every possible trouble, but will be an aid in systematically isolating faulty components.

Figure 6-1. Initial Checks

Figure 6-2. Generator Mode Checks

- Sheet 1 Generator Check
- Sheet 2 Synthesizer Loop Checks
- Sheet 3 VCG Check
- GCV Check
- TTL Check

Figure 6-3. Power Supply Checks

Figure 6-4. Synthesizer Mode Checks

- Sheet 1 F/V Check
- Sheet 2 Synthesizer Loop Checks
- Sheet 3 Synthesizer Loop Checks
- Sheet 4 Frequency Ranging Check
- Sheet 5 Generator Phase Lock Loop Check
- Sheet 6 Reference Selector Check

6.3 TROUBLESHOOTING INDIVIDUAL COMPONENTS

6.3.1 Transistor

1. A transistor is defective if more than one volt is measured across its base emitter junction in the forward direction.

2. A transistor when used as a switch may have a few volts reverse bias voltage.
3. If the collector and emitter voltages are the same, but the base emitter voltage is less than 500 mV forward voltage (or reversed bias), the transistor is defective.
4. A transistor is defective if its base current is larger than 10% of its emitter current (calculate currents from voltage across the base and emitter series resistors).
5. In a transistor differential pair (common emitter stages), either their base voltages are the same in normal operating condition, or the one with less forward voltage across its base emitter junction should be off (no collector current); otherwise, one of the transistors is defective.

6.3.2 Diode

1. A diode is defective if there is greater than one volt (typically 0.7 volt) forward voltage across it.

6.3.3 Operational Amplifier (e.g., UA741C, LM318)

1. The "+" and "-" inputs of an operational amplifier will have less than 15 mV voltage difference when operating under normal conditions.
2. If the output voltage stays at maximum positive, its "+" input voltage should be more positive than its "-" input voltage, or vice versa; otherwise, the operational amplifier is defective.

6.3.4 Capacitor

1. Shorted capacitors have zero volts across their terminals.
2. Opened capacitor can be located (but not always) by using a good capacitor connected in parallel with the capacitor under test and observing the resulting effect.

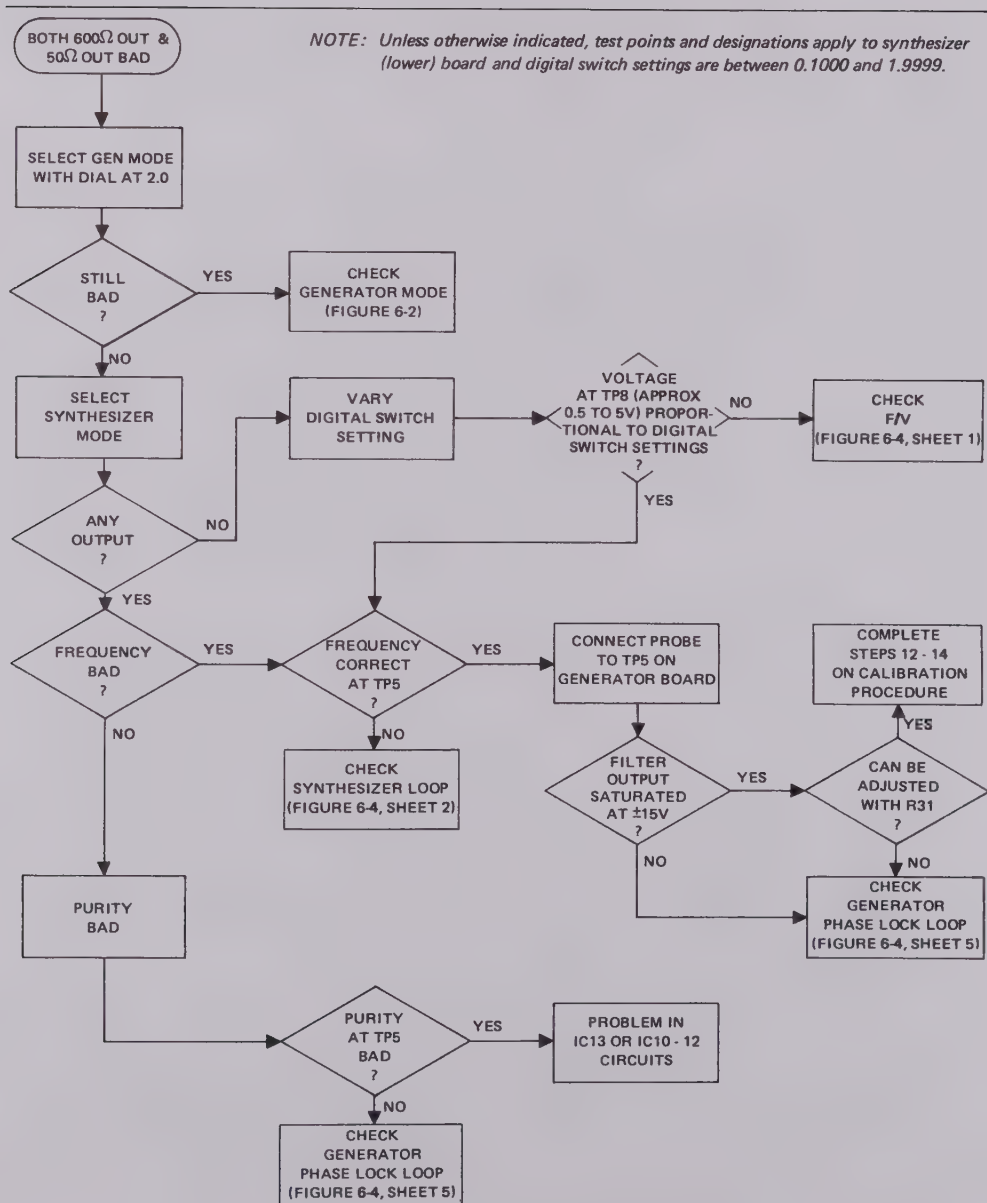


Figure 6-1. Initial Checks

GENERATOR CHECK

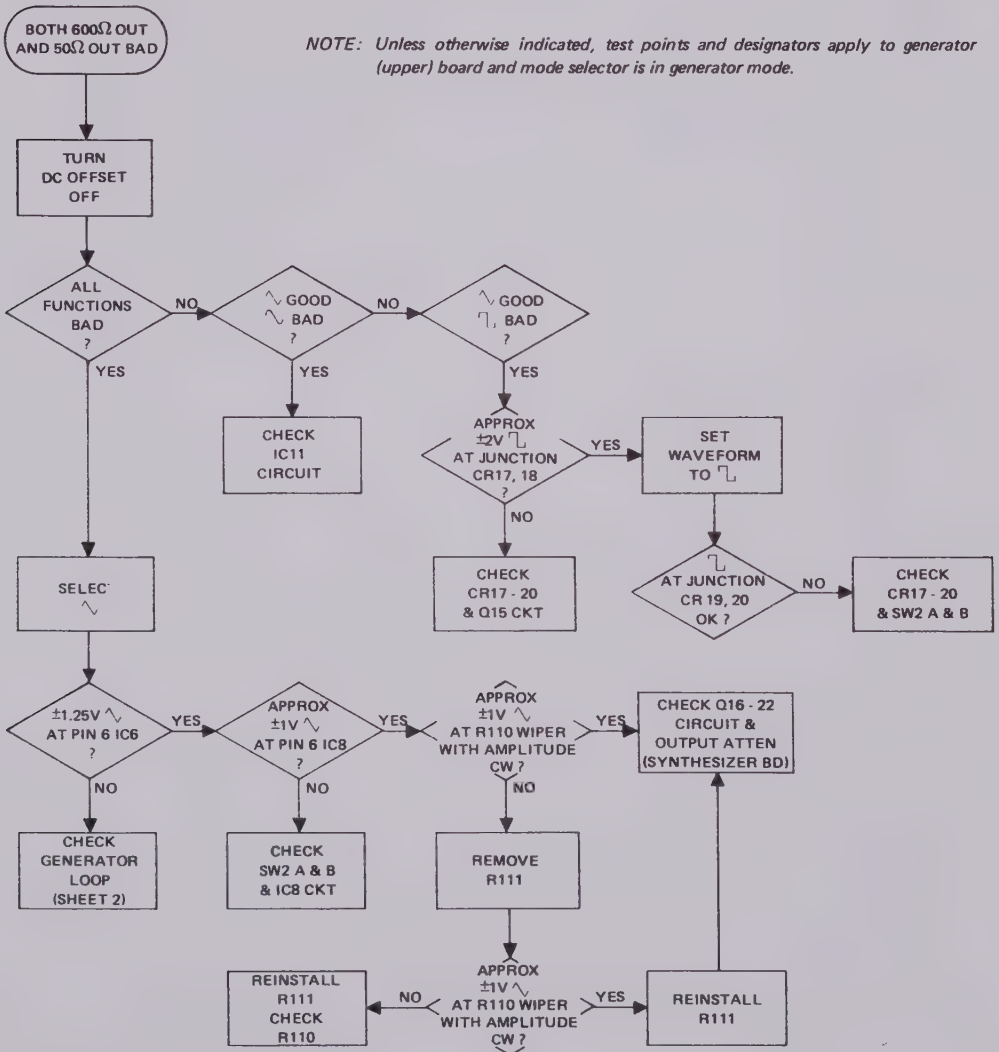


Figure 6-2. Generator Mode Checks (Sheet 1 of 3)

GENERATOR LOOP CHECK

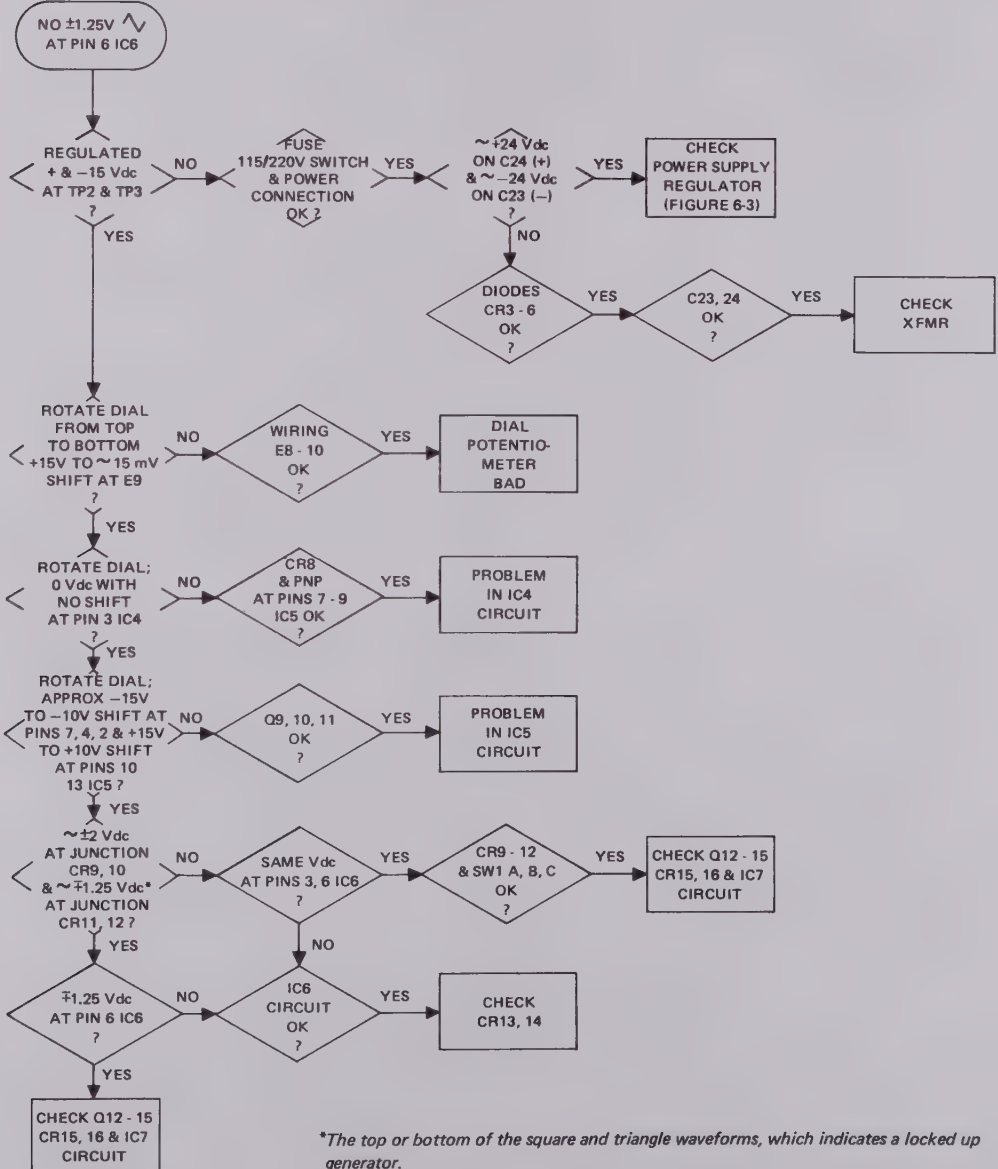


Figure 6-2. Generator Mode Checks (Sheet 2 of 3)

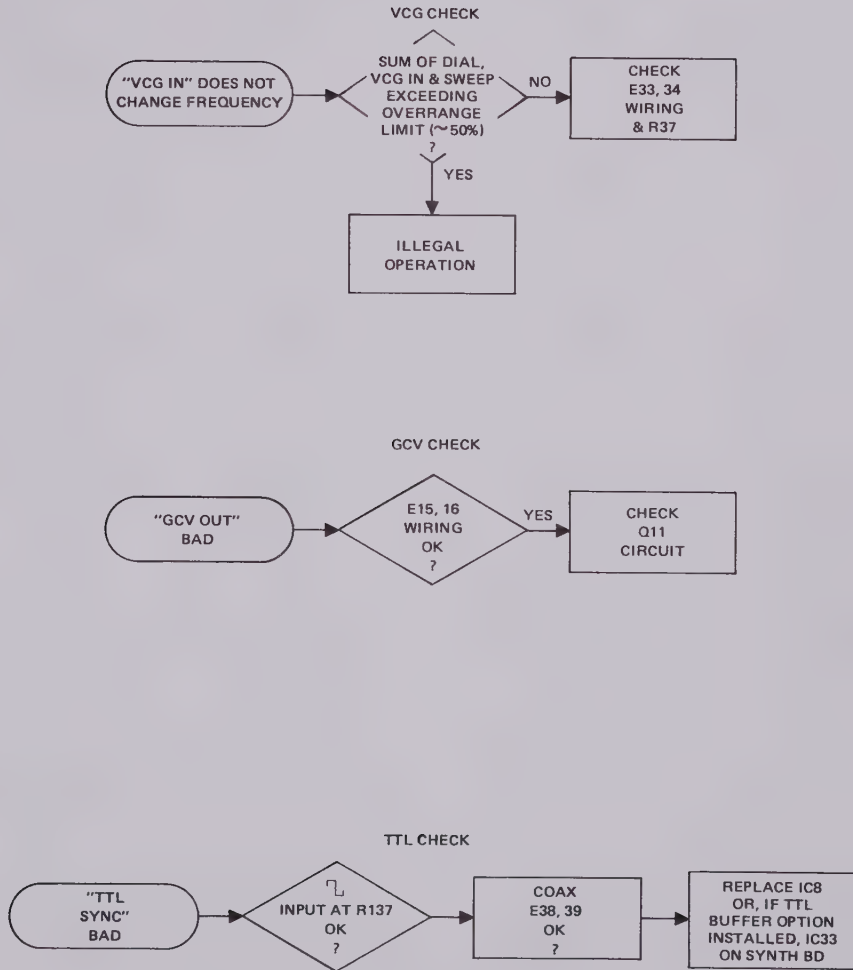


Figure 6-2. Generator Mode Checks (Sheet 3 of 3)

NOTE: Test points and designators apply to generator (upper) board.

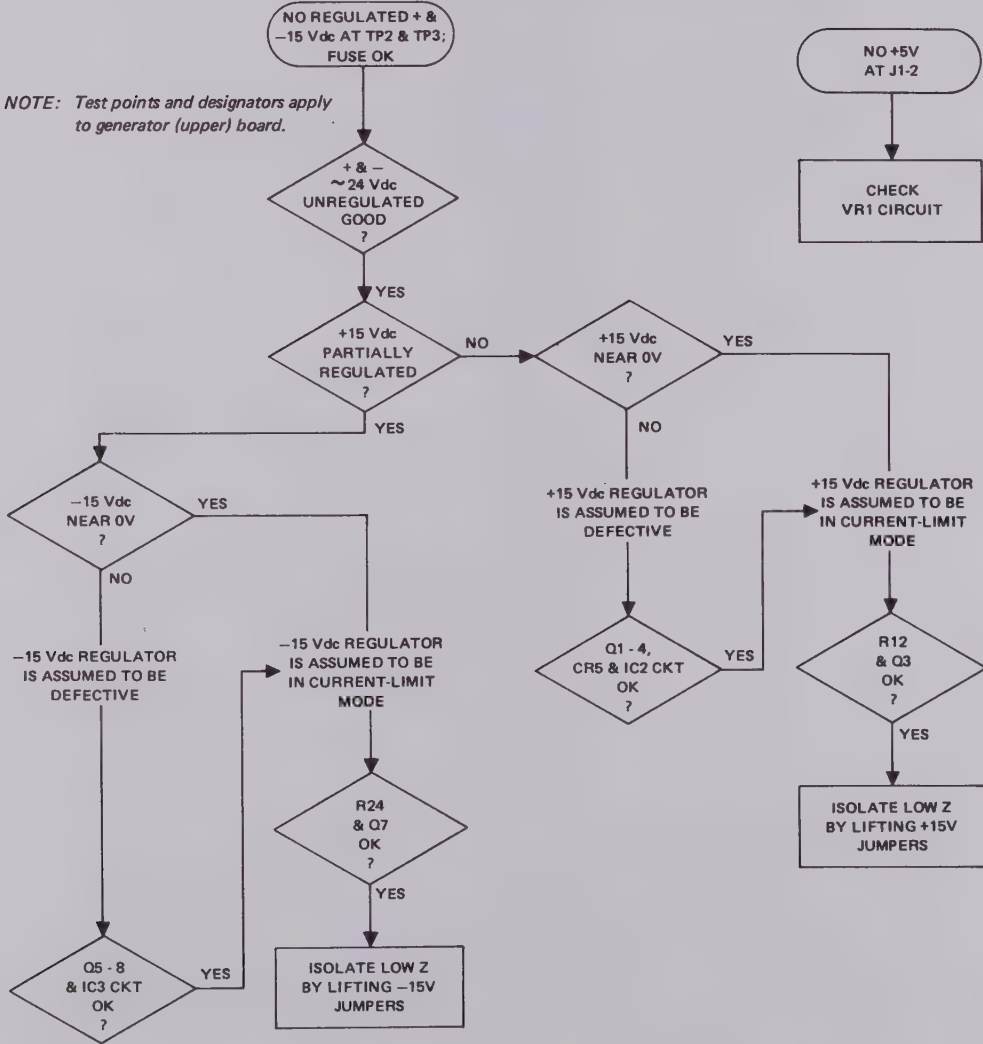


Figure 6-3. Power Supply Checks

NOTE: Unless otherwise indicated, test points and designations apply to synthesizer (lower) board and digital switch settings are between 0.1000 and 1.9999.

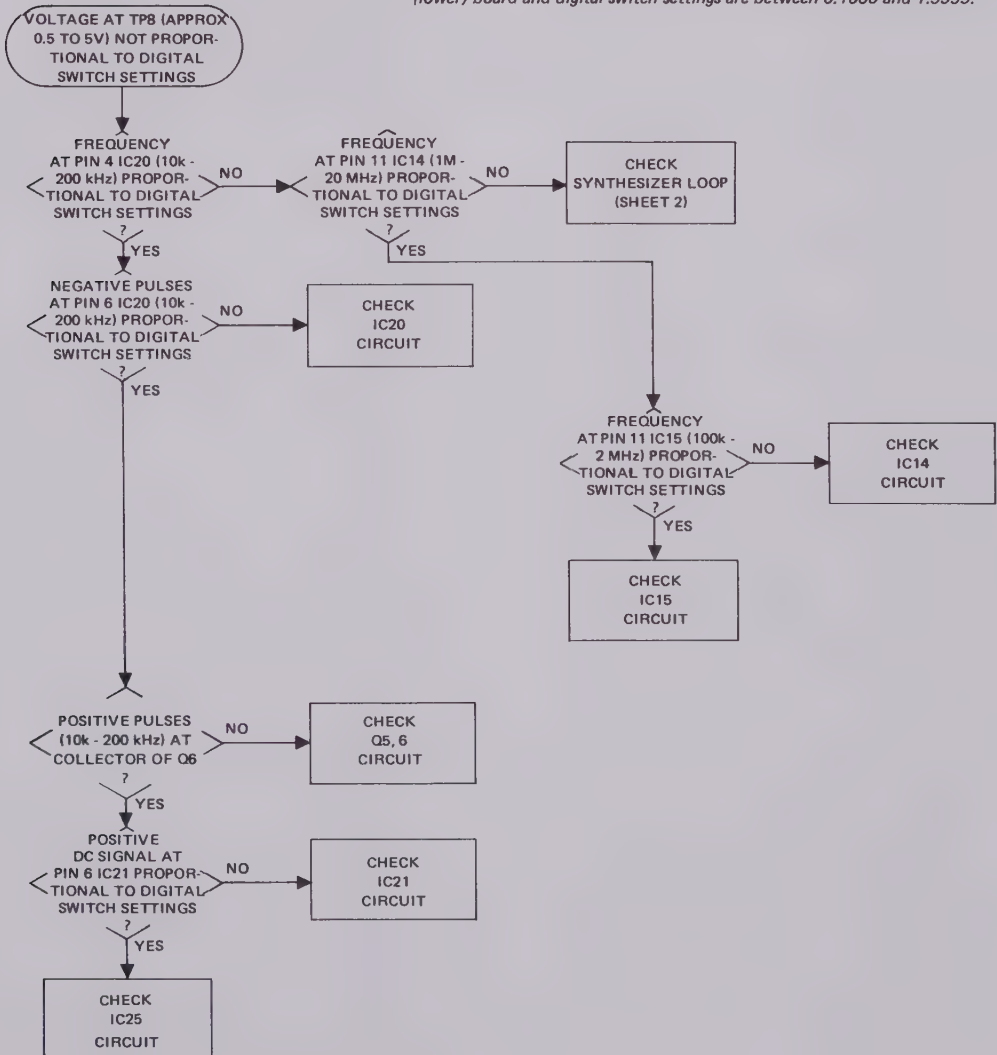


Figure 6-4. Synthesizer Mode Checks (Sheet 1 of 6)

SYNTHESIZER LOOP CHECK

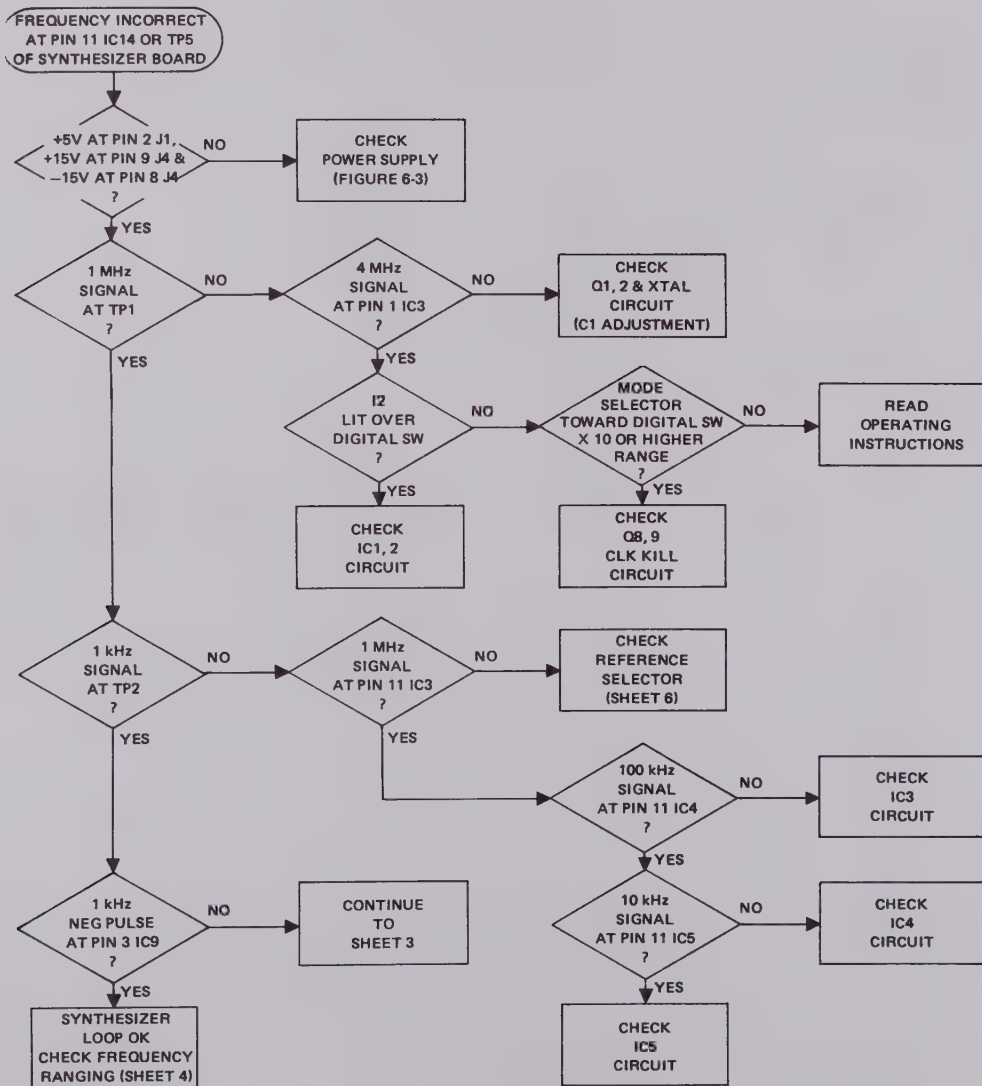
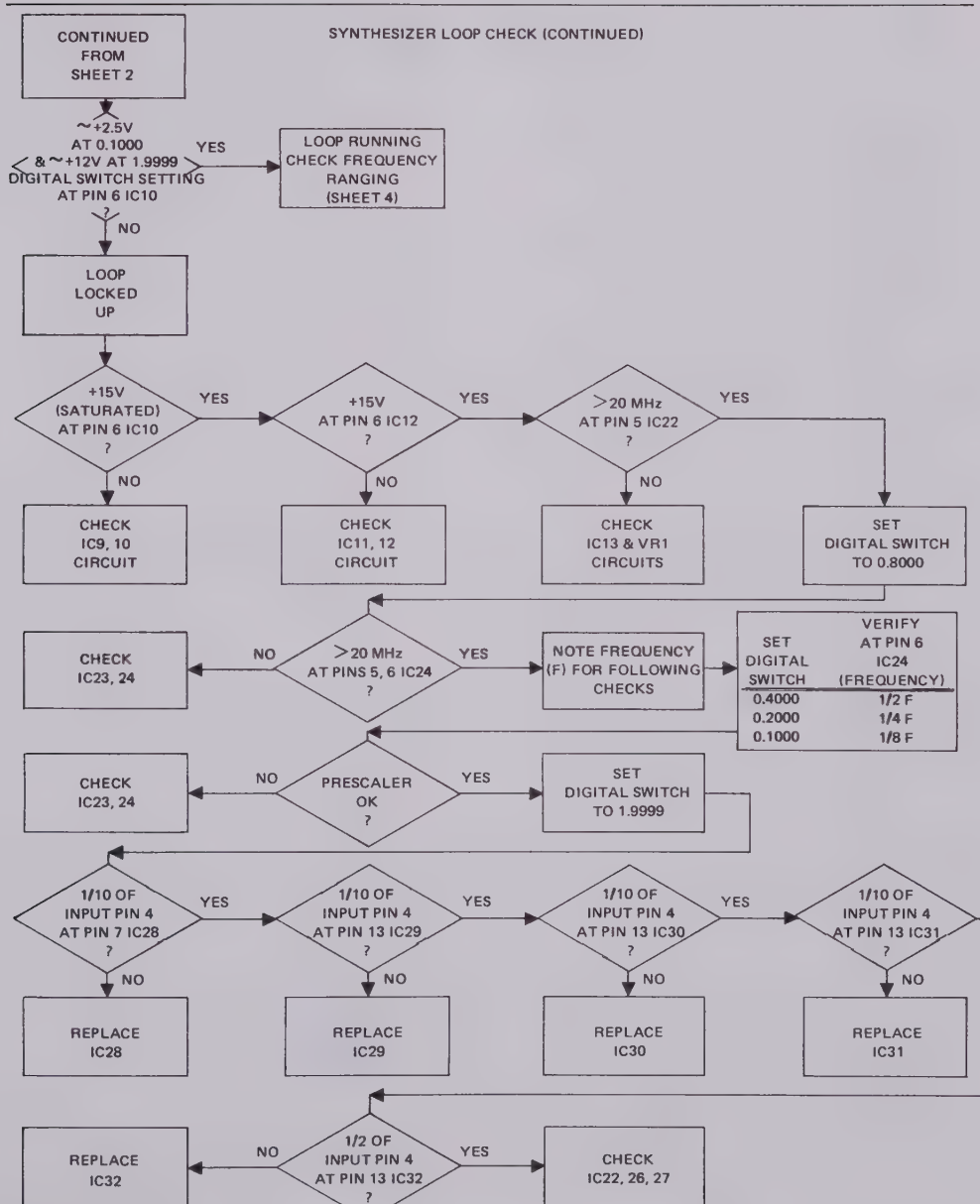


Figure 6-4. Synthesizer Mode Checks (Sheet 2 of 6)



FREQUENCY RANGING CHECK

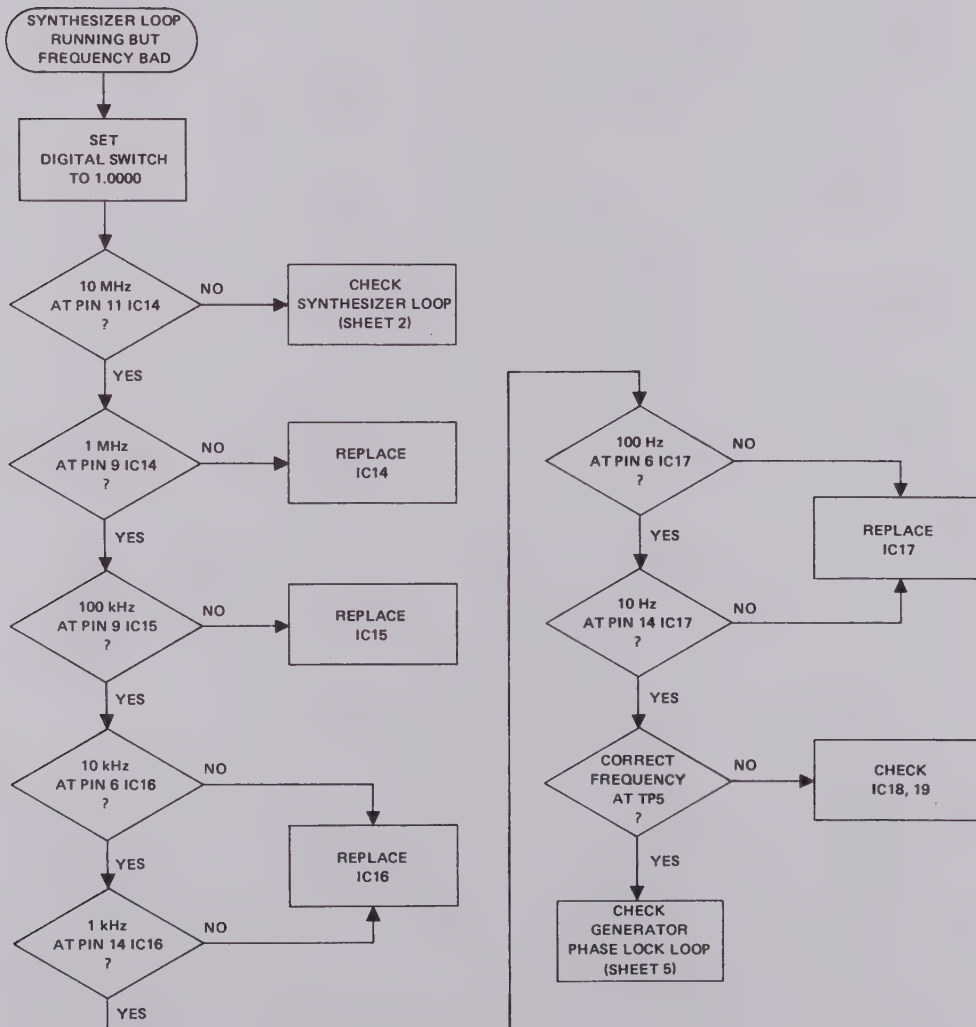


Figure 6-4. Synthesizer Mode Checks (Sheet 4 of 6)

GENERATOR PHASE LOCK LOOP CHECK
(GENERATOR BOARD)

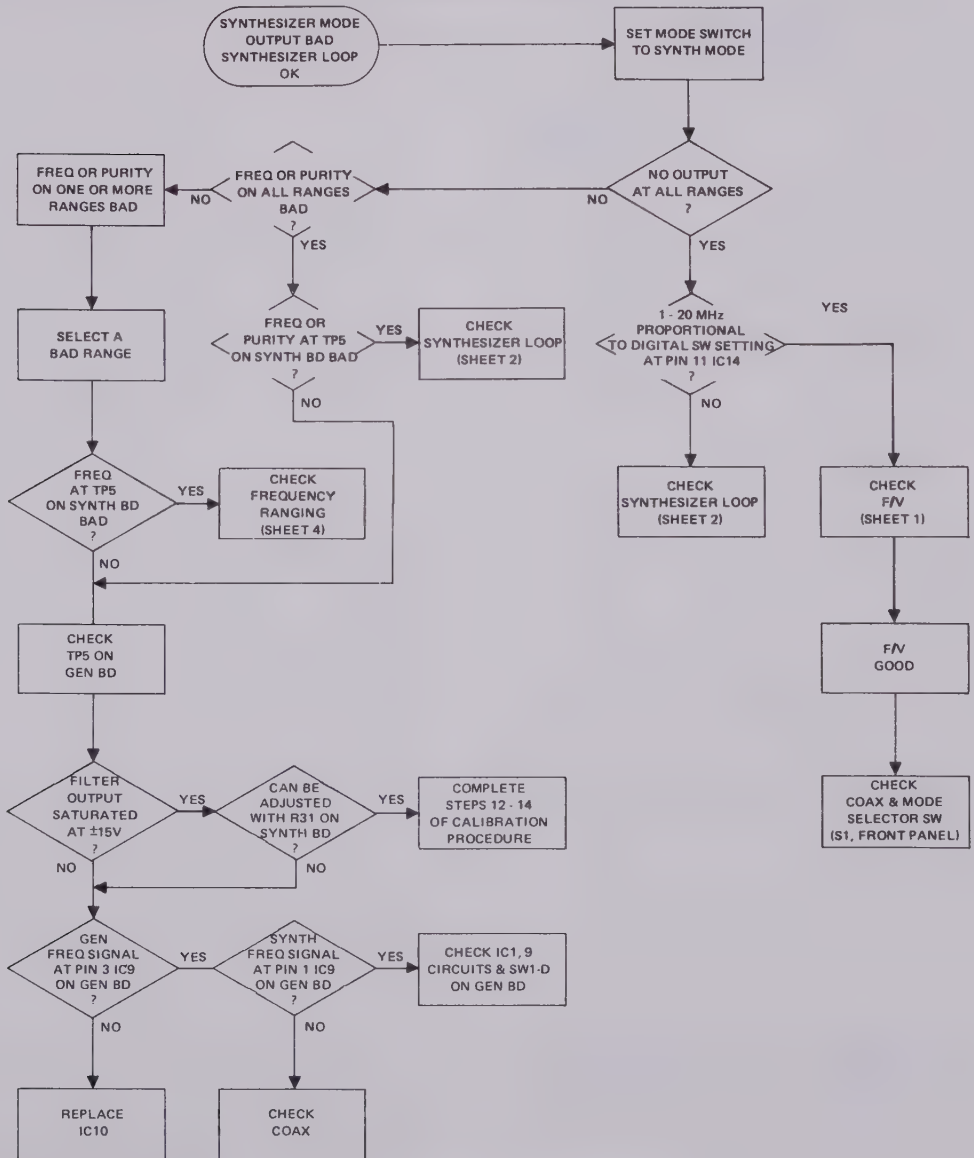


Figure 6-4. Synthesizer Mode Checks (Sheet 5 of 6)

REFERENCE SELECTOR CHECK

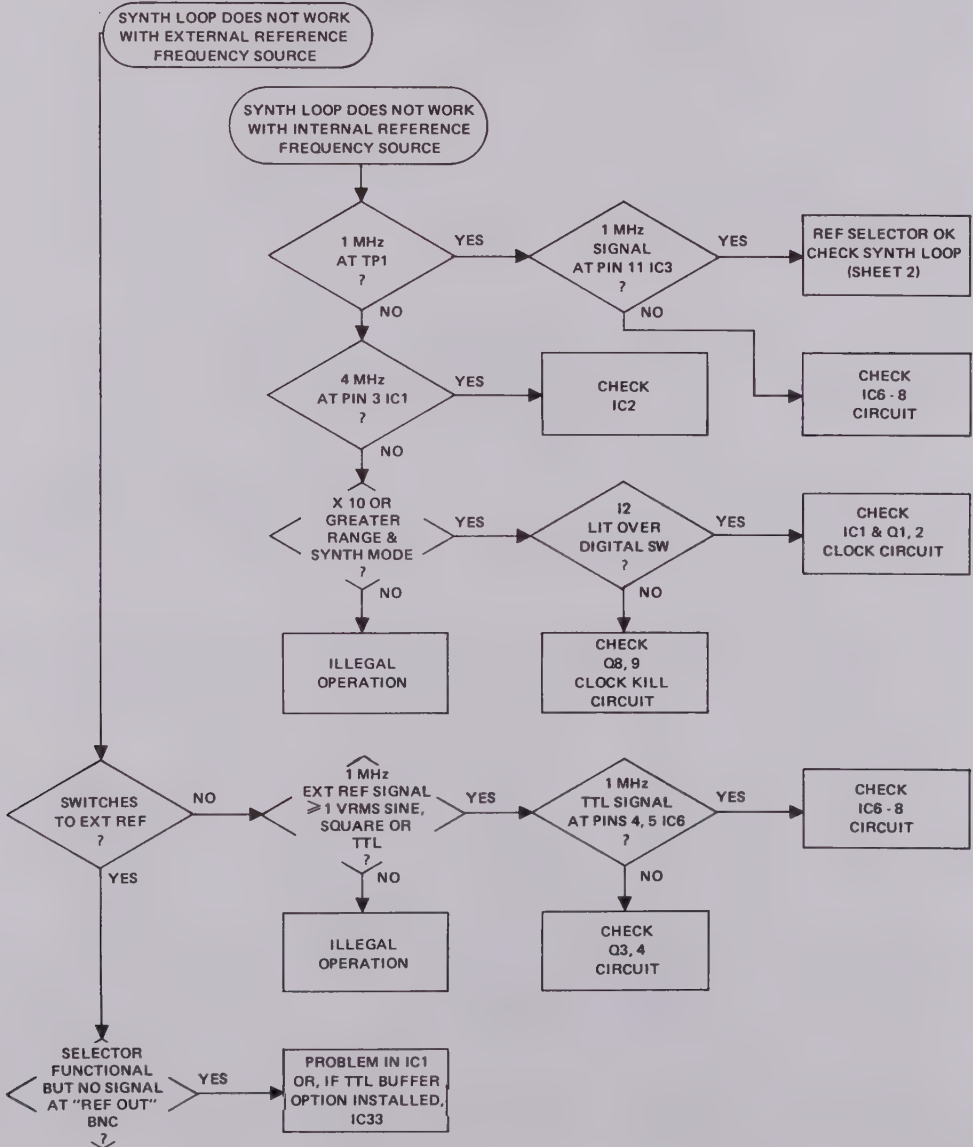


Figure 6-4. Synthesizer Mode Checks (Sheet 6 of 6)

7

SECTION

PARTS AND SCHEMATICS

7.1 DRAWINGS

The following assembly drawings, parts lists and schematics are in the arrangement shown below.

7.2 ORDERING PARTS

When ordering spare parts, please specify part number, circuit reference, board, serial number of unit and the function performed.

7.3 ADDENDA

Under Wavetek's product improvement program, the latest electronic designs and circuits are incorporated into each Wavetek instrument as quickly as development and testing permit. Because of the time needed to compose and print instruction manuals, it is not always possible to include the most recent changes in the initial printing. Whenever this occurs, addendum pages are prepared to summarize the changes made and are inserted immediately inside the rear cover.

DRAWING

Chassis Schematic
Chassis Assembly
Chassis Parts List

Main Board Schematic
Main Board Assembly
Main Board Parts List

Synthesizer Schematic
Synthesizer Assembly
Synthesizer Parts List

Piggyback Board Parts List

DRAWING NUMBER

0004-00-0095
0102-00-0510
1101-00-0510

0103-00-0213
0101-00-0213
1100-00-0213

0103-00-0225
0101-00-0225
1100-00-0225

1208-00-2252

REFERENCE SELECTOR CHECK

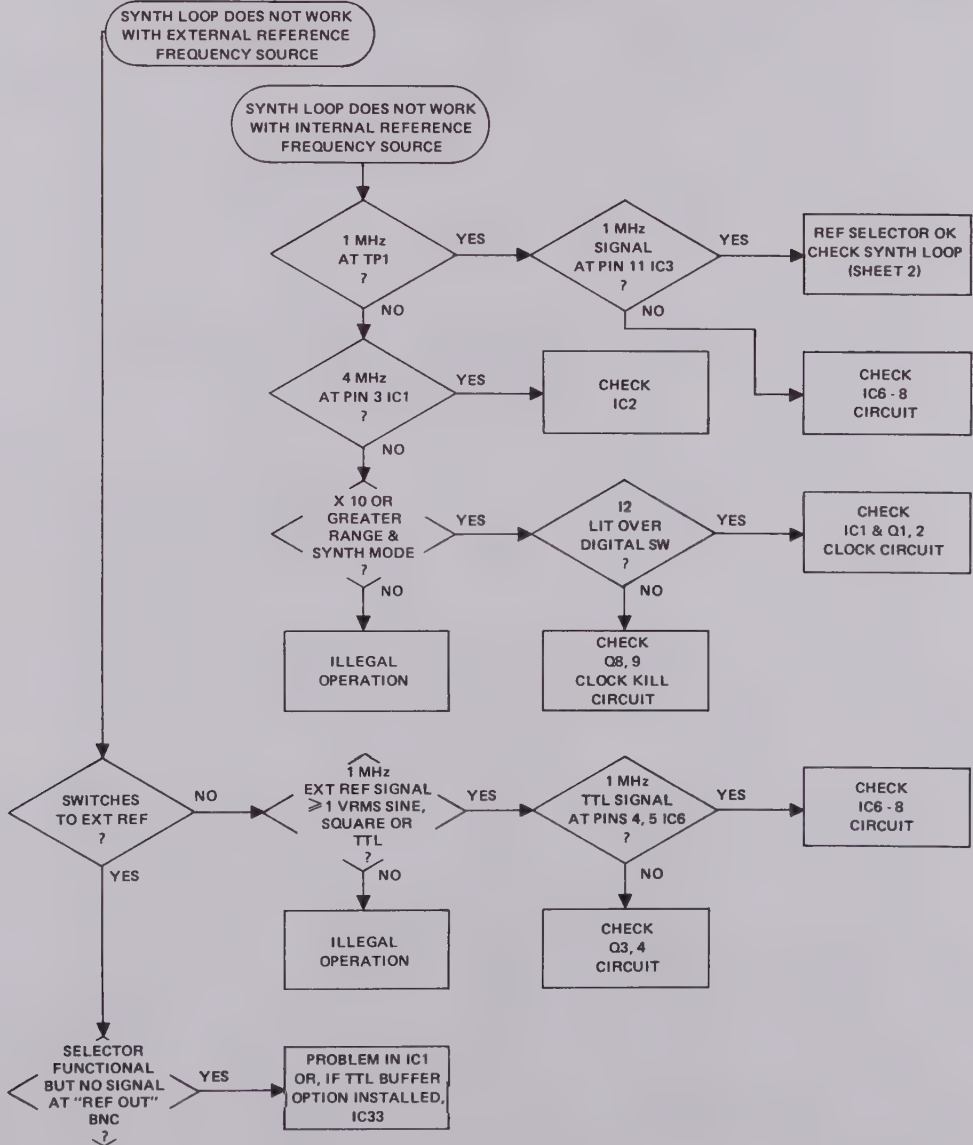
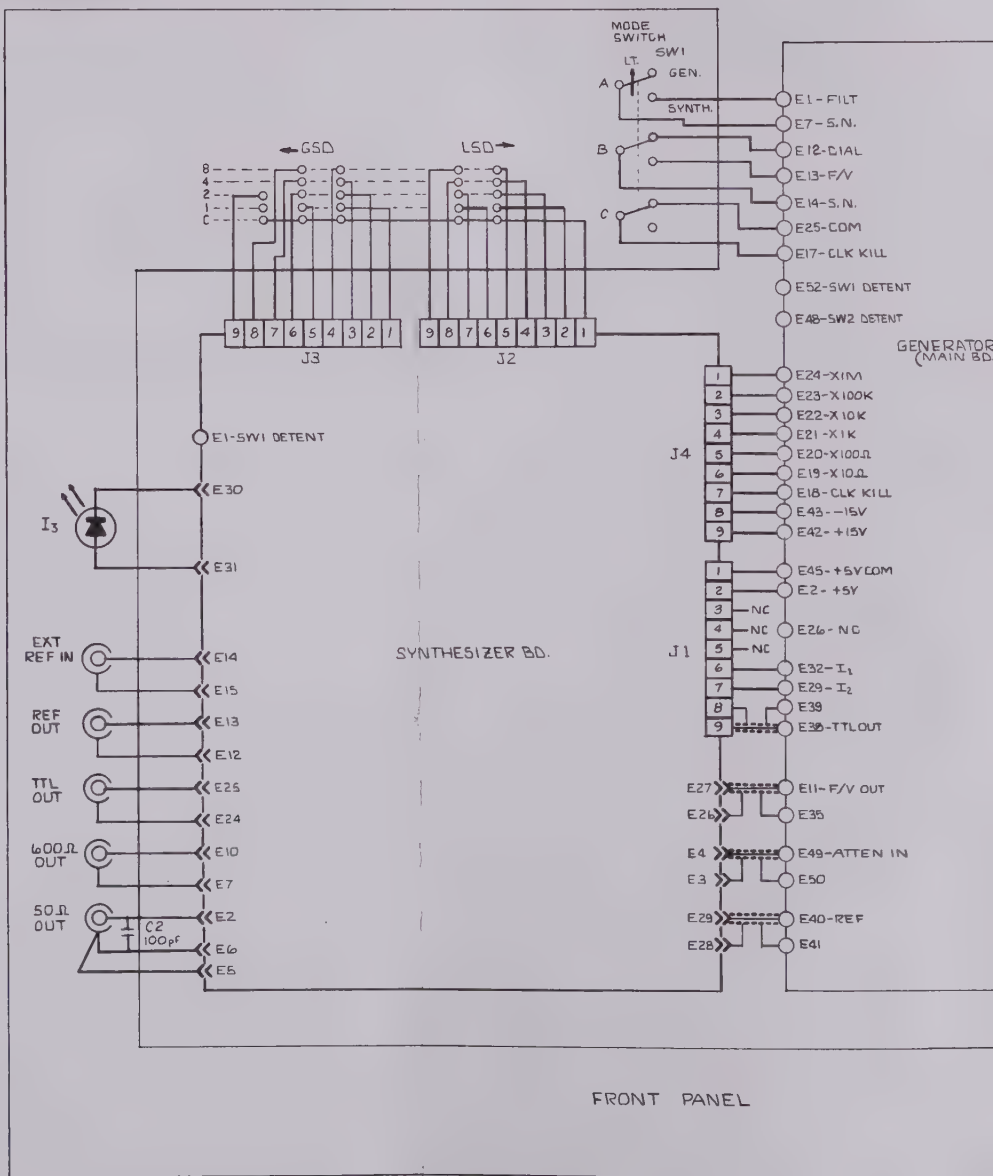


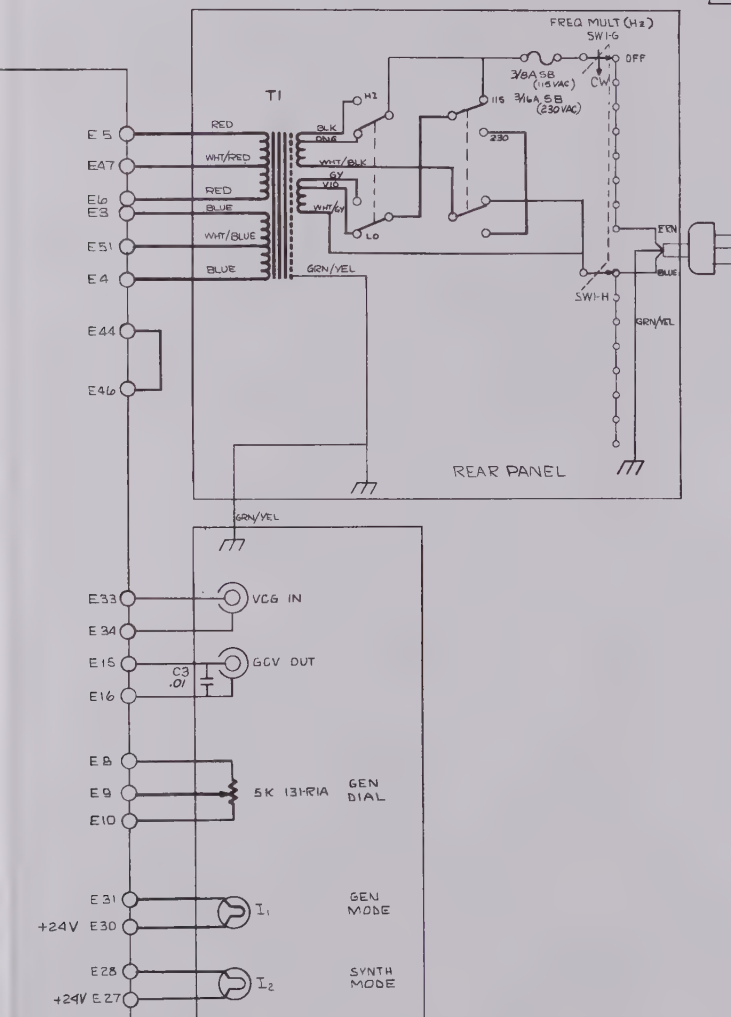
Figure 6-4. Synthesizer Mode Checks (Sheet 6 of 6)

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NOTE: UNLESS OTHERWISE SPECIFIED

REV	ECN	BY	DATE	APP
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B	ECN 1808	JRM	9-19-8	

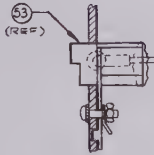


REMOVE ALL BURRS AND BREAK SHARP EDGES	GRAND	DATE	 SAN DIEGO • CALIFORNIA
	20	3-31-76	
MATERIAL	PROJECT	4-12-76	TITLE CHASSIS SCHEMATIC (INSTRUMENT)
	76		
FINISH WAVETEK PROCESS	DESIGN APPROV	4-12-76	TOLERANCE UNLESS OTHERWISE SPECIFIED XXX .010 ANGLES-.1 XX .005
	SCALE		
	DO NOT SCALE DWG		
	MODEL NO	DWG NO	
	171	0004-00-0095	1
CODE	21338	SHEET	OF

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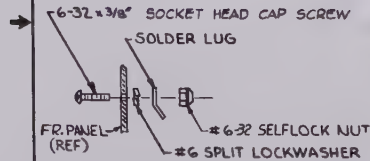
SEE DETAIL C

D



DETAIL A

C



DETAIL B

B

HARDWARE STACK UP FOR GROUND LUG (TYP 3 PLACES)

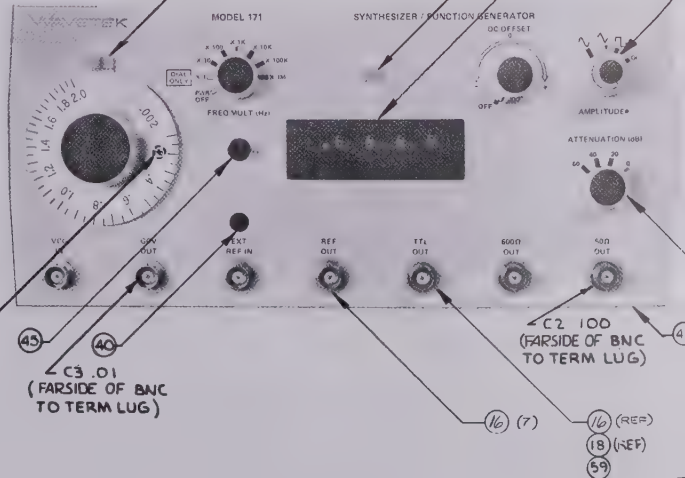
NOTE: ALL CONNECTIONS TO BE MECHANICALLY SECURE TO LUGS PRIOR TO SOLDERING GROUND WIRES.

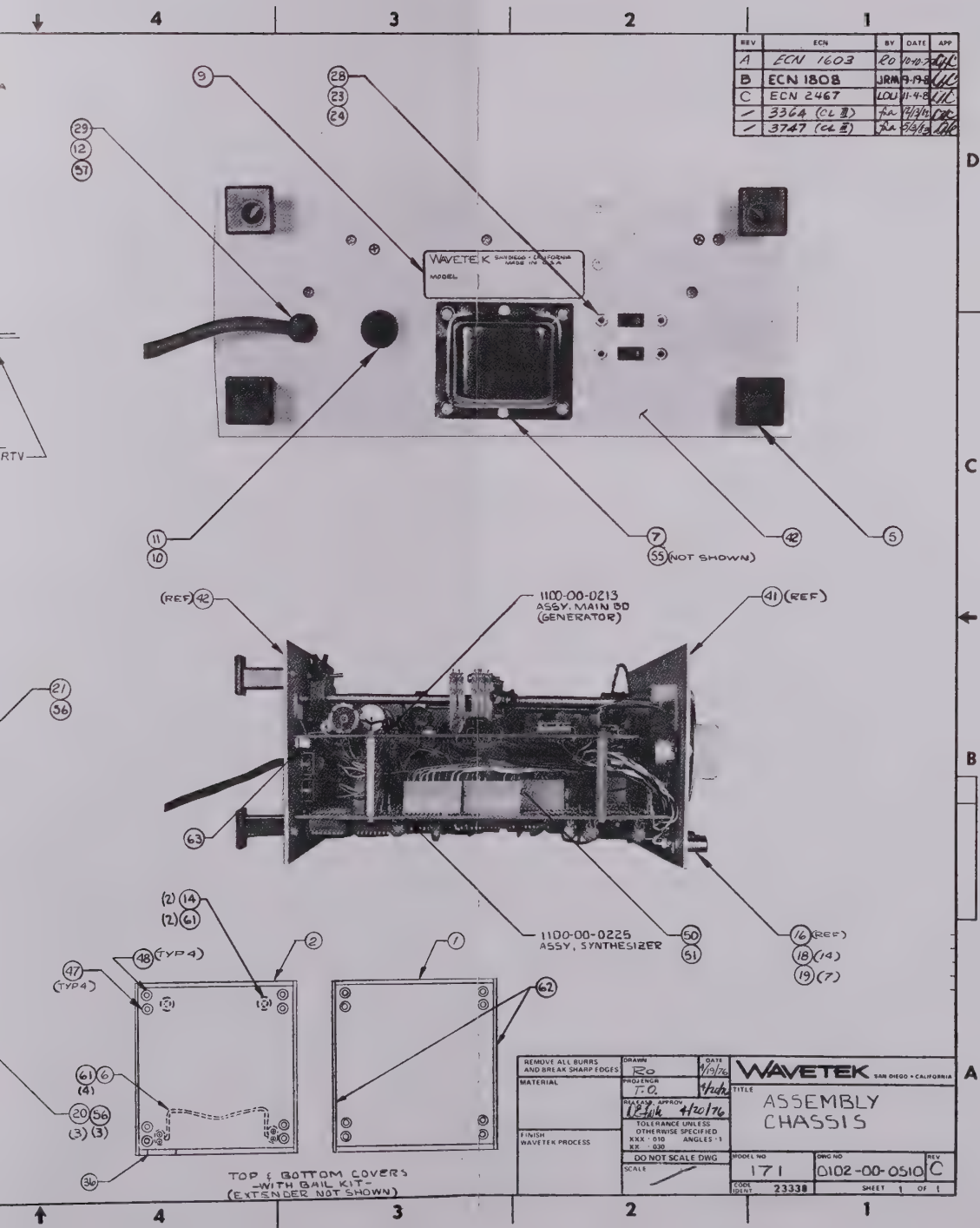
A

SEE DETAIL B (SAFETY GND FAR SIDE)

C3 .01 (FAR SIDE OF BNC TO TERM LUG)

NOTE: UNLESS OTHERWISE SPECIFIED





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D

LOW PASS FILTERS

C

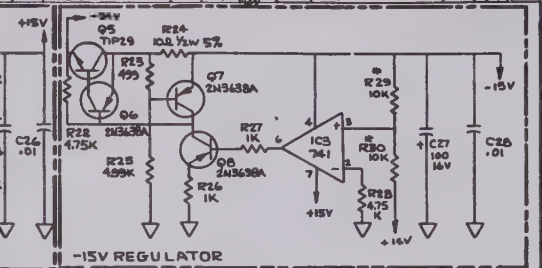
B

A

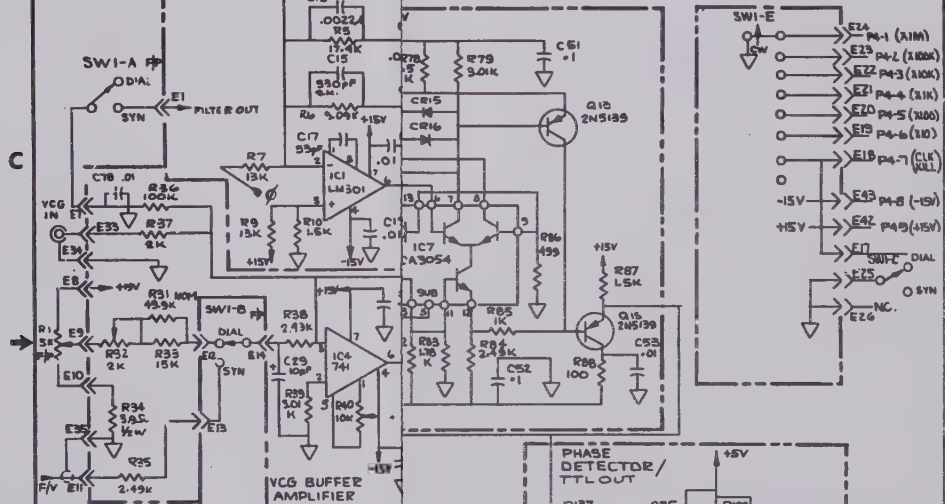
4. * NOM. VALUE CALLED OUT ON P/L
3. DIODES ARE F060000.
2. CAPACITANCE IS IN MICROFARADS.
1. RESISTANCE IS IN OHMS.

NOTE: UNLESS OTHERWISE SPECIFIED

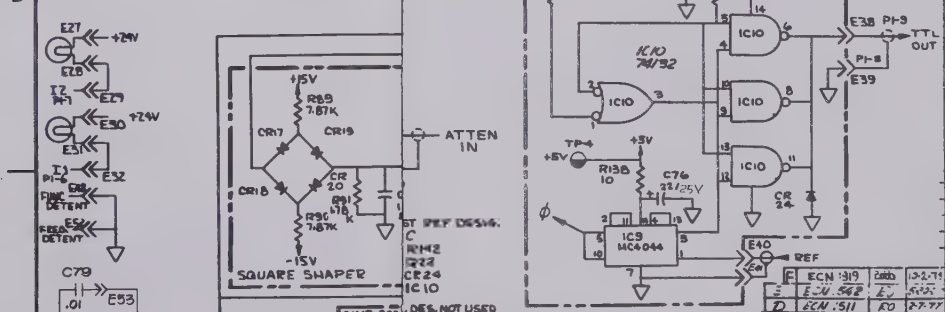
G 2491, 2535 LDK 1/1/81 1/200 REV ECH BY DATE APP
H 2503 LDK 2/16/81 1/200 B AM 1430 DMC 5/24/81



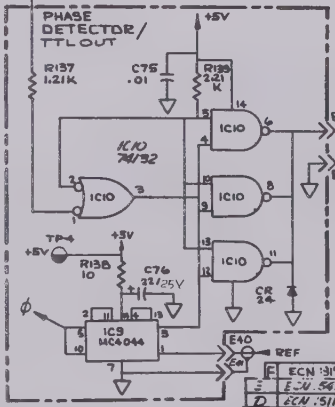
-15V REGULATOR



VCG BUFFER AMPLIFIER



SQUARE SHAPER



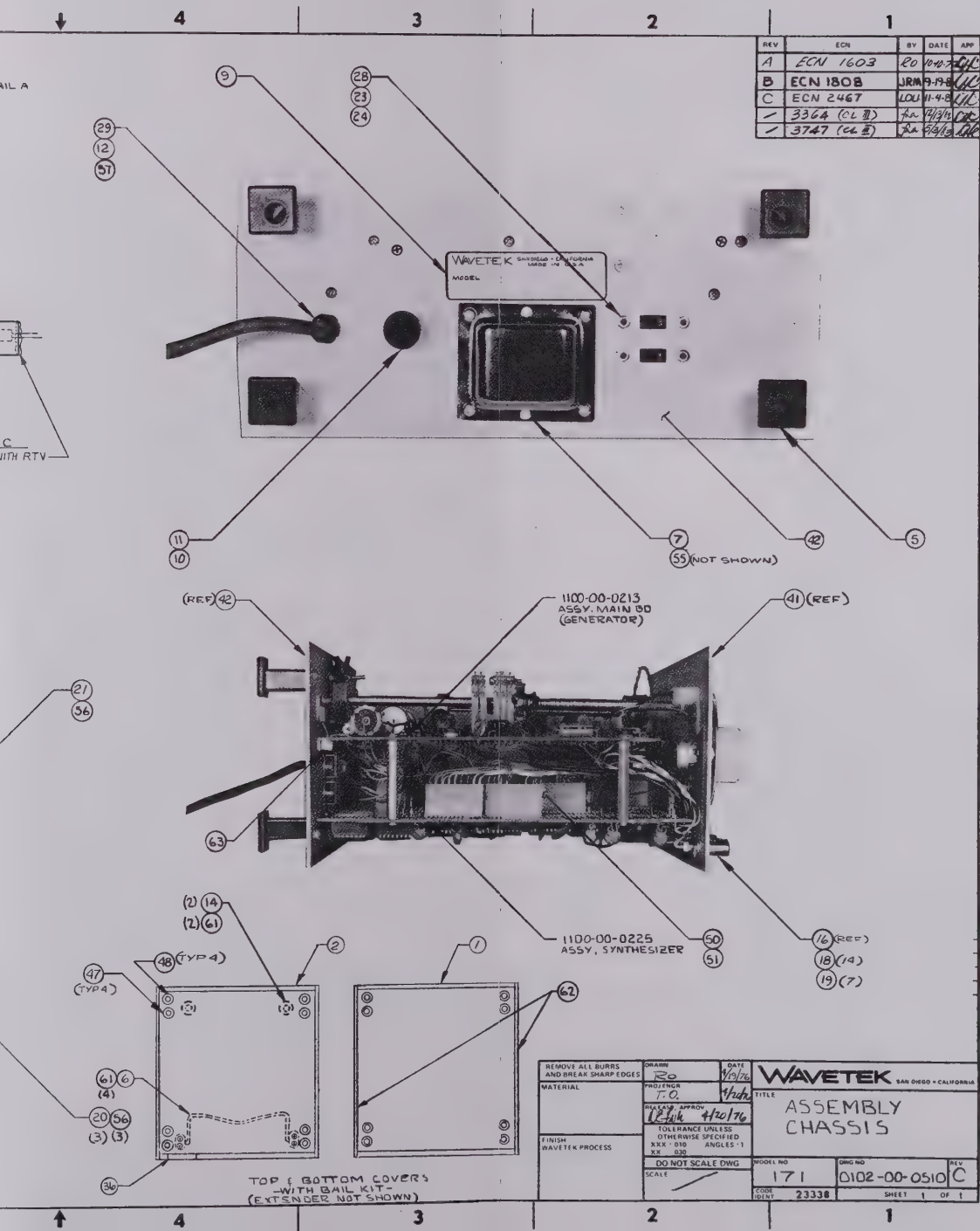
PHASE DETECTOR/TTL OUT

DES. NOT USED

REMOVE ALL BURRS AND BREAK SHARP EDGES		DATE 3-27-76	WAVETEK SAN BROS - CALIFORNIA	
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FRACTION WAVETEK PROCESS		TOLERANCE UNLESS OTHERWISE SPECIFIED XX - 1/100 XX - 1/50	MODEL NO 171	
DO NOT SCALE DWG		SCALE	SHEET NO 23338	REV
SINE CO		0103-00-0213		P

0103-00-0213

A



REV	ECN	BY	DATE	APP
A	ECN 1603	ED	10-10-77	WJL
B	ECN 1808	JRM	9-19-80	WJL
C	ECN 2467	LDU	11-9-80	WJL
-	3364 (CL III)	LR	12/1/81	WJL
-	3747 (CL III)	LR	8/1/82	WJL

REMOVE ALL BURRS AND BREAK SHARP EDGES		CHARGE	DATE	WAVETEK SAN DIEGO - CALIFORNIA	
MATERIAL		PROTECTOR	10/10/76	TITLE	
FINISH WAVETEK PROCESS		T.O.		ASSEMBLY CHASSIS	
TOLERANCE UNLESS OTHERWISE SPECIFIED		1/16" ±0.016		MODEL NO	
XX - 010 ANGLES - 1		DO NOT SCALE DWG		DWG NO	
SCALE		171		0102-00-0510	
CODE		23338		REV C	
DATE		23338		SHEET 1 OF 1	

THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION AND DESIGN RIGHTS BELONGING TO SATELLITE AND MAY NOT BE REPRODUCED FOR ANY REASON EXCEPT CALCULATION, OPERATION, AND MAINTENANCE WITHOUT WRITTEN AUTHORIZATION.

P 7502 07/6/1962 EXT M 4406,4692,4659 04/1/72
N 4744 A.R.T. 6-1

D

LOW PASS FILTERS

SW1-A

SW1-B

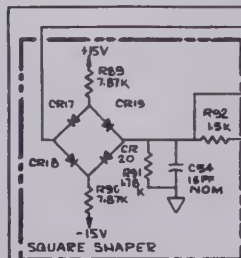
C

B

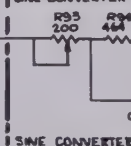
A

4. * NOM VALUE CALLED OUT ON P/L
3. DIODES ARE F000000.
2. CAPACITANCE IS IN MICROFARADS.
1. RESISTANCE IS IN OHMS.

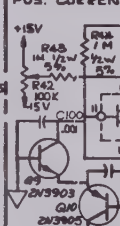
NOTE: UNLESS OTHERWISE SPECIFIED



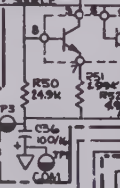
SINE CONVERTER



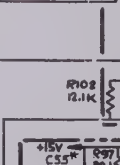
POS. CURRENT SOURCE



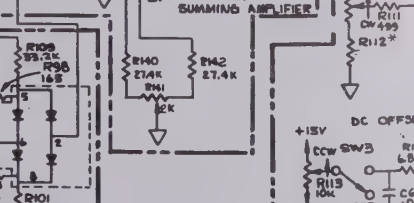
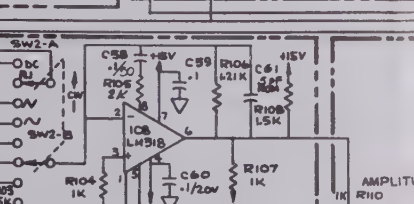
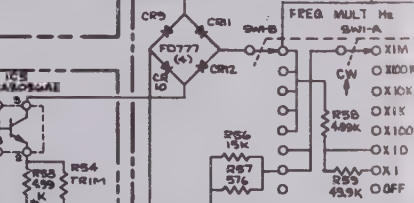
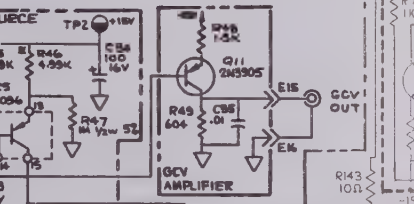
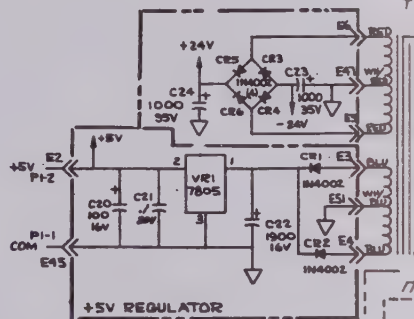
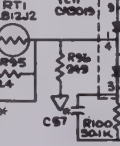
NEG. CURRENT SOURCE

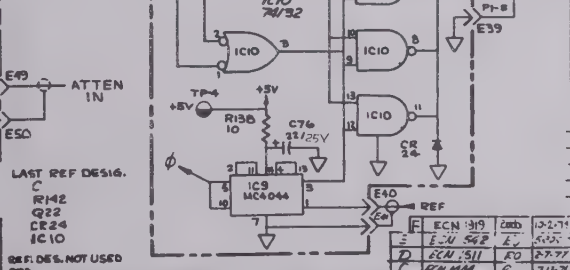
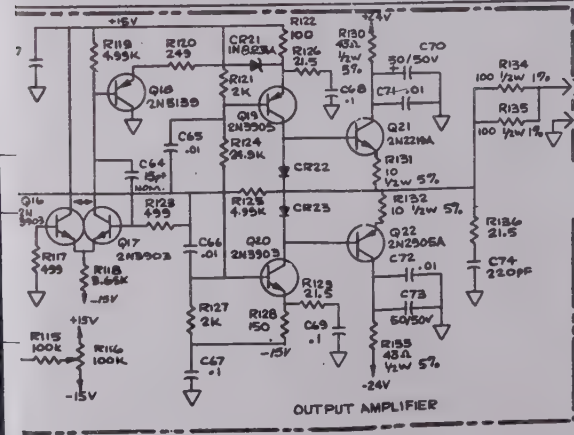
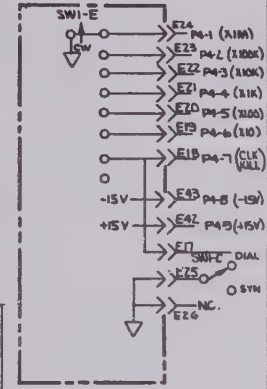
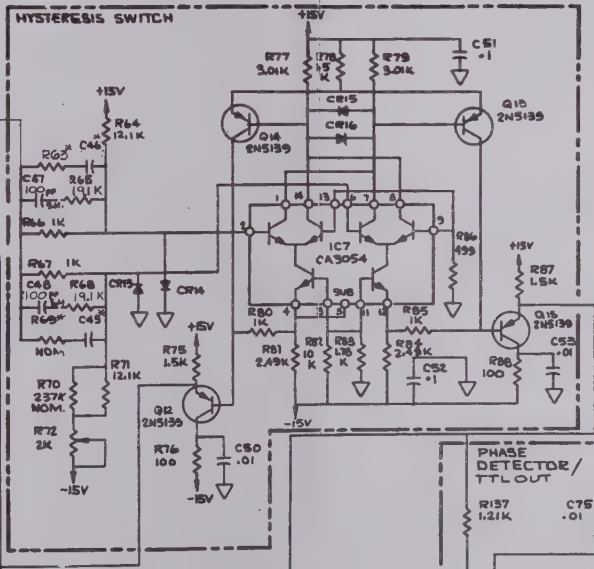
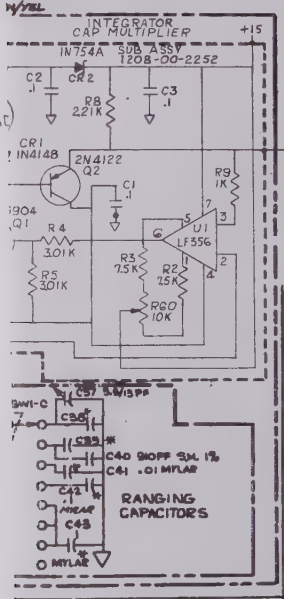
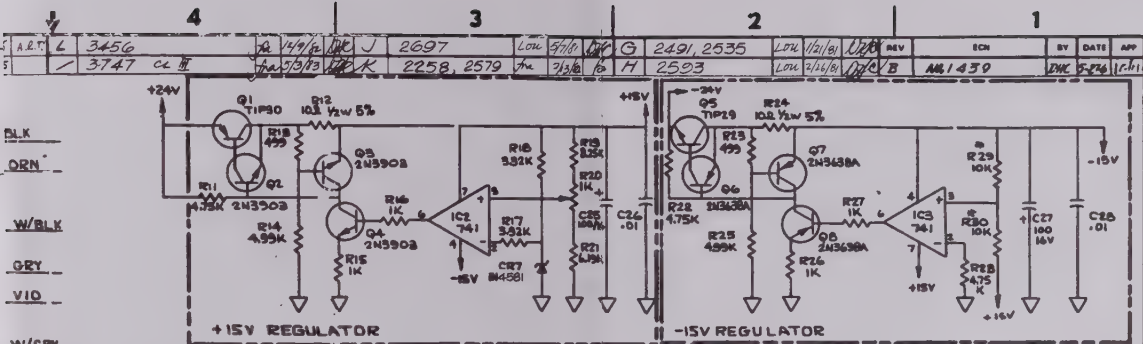


SUMMING AMPLIFIER



DC OFF





REMOVED ALL BURRS AND BREAK SHARP EDGES		DATE 3-27-76	
MATERIAL		T.O. 4-12-76	
FINISH WAVETEC PROCESS		DO NOT SCALE	
SCALE		TITLE	
MODEL NO 171		SHEET NO 23338	
SHEET 1 OF 1		P	

WAVETEK		SAN DIEGO - CALIFORNIA	
SCHEMATIC MAIN BOARD		REV 1	
0103-00-0213		P	

THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION AND DESIGN RIGHTS BELONGING TO WAVETEK AND MAY NOT BE REPRODUCED FOR ANY REASON EXCEPT CALIBRATION, OPERATION, AND MAINTENANCE WITHOUT WRITTEN AUTHORIZATION.

D

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-NFOR-PART-NO	NFOR	WAVETEX NO.	QTY/PT	
NONE	ASSY DRWG. MAIN	0101-00-0213	WVTK	0101-00-0213	1	
NONE	SCHEMATIC. MAIN	0103-00-0213	WVTK	0103-00-0213	1	
NONE	ASSY. COAX 171-0213	171-1949	WVTK	1207-00-1949	1	
NONE	ASSY. COAX 171-0213	171-1950	WVTK	1207-00-1950	1	
NONE	ASSY. COAX 171-0213	171-1951	WVTK	1207-00-1951	1	
NONE	ASSY. COAX 171-0213	171-1952	WVTK	1207-00-1952	1	
NONE	ASSY. LAMP 171-0213	171-1954	WVTK	1207-00-1954	1	
NONE	ASSY. LAMP 171-0213	171-1955	WVTK	1207-00-1955	1	
NONE	ASSY. P16P4 HARNESS 171-0213	171-1957	WVTK	1207-00-1957	1	
NONE	ASSY. P16P4 HARNESS 171-0213	171-1958	WVTK	1207-00-1958	1	
NONE	SPK ASSY. P100YBACK B3MWB	171-2252	WVTK	1208-00-2252	1	
1	SPACER	0480	WVTK	1400-00-0453	4	
NONE	PLATE. BM	008-004	WVTK	1400-00-2130	2	
C61T	CAP. CER. 5PF. 1KV	DD-050	CRL	1500-00-5011	1	
C100- C31 C33	CAP. CER. .001MF. 1KV	DD-102	CRL	1500-01-0211	3	
WAVETEK PARTS LIST		TITLE MAIN		ASSEMBLY NO. 1100-00-0213		REV. M
PAGE 1						

PAGE 1

REFERENCE DESIGNATORS	PART DESCRIPTION
C20 C25 C27 C3 C34 C36 C4	CAP. ELECT. 100MF.
C23 C24	CAP. ELECT. 1000MF.
C22	CAP. ELECT. 1900MF.
C76	CAP. ELECT. 22MF.
C70 C73	CAP. ELECT. 50MF.
C13	POLY. .0022MF.
C12 C16 C8	POLY. .022MF.
C5	CAP. POLY. .22MF.
C14	POLY. .05MF.
C37	VAR. 1.3. 5-13PF.
C10 C9	CAP. TANT. 1MF.
C29 C6 C7	CAP. TANT. 10MF.
C1 C2	CAP. TANT. 4.7MF.
C41 C42 C43	CAP. SET. POLY. MATCHED SET
NONE	MAIN
C38A C38B C39A C39B	PIN SOCKET
WAVETEK PARTS LIST	
TITLE MAIN	

C

→

B

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-NFOR-PART-NO	NFOR	WAVETEX NO.	QTY/PT	
C79	CAP. CER. .01MF. 1KV	GAP-103	CRL	1500-01-0309	1	
C18 C19 C26 C28 C30 C32 C35 C50 C53 C63 C65 C66 C71 C72 C75 C78	CAP. CER. MH. .01MF. 50V	QE30-1032A	MURAT	1500-01-0310	16	
C21 C31 C52 C58 C59 C60 C67 C68 C69 C77	CAP. CER. MON. .1MF. 50V	CAC0329U1042050A	CDRNG	1500-01-0405	10	
C54T C64T	CAP. CER. 15PF. 1KV	DD-150	CRL	1500-01-5011	2	
C74	CAP. CER. 220PF. 1KV	DD-221	CRL	1500-02-2111	1	
C17	CAP. CER. 33PF. 1KV	DD-330	CRL	1500-03-3011	1	
C35T	CAP. CER. 47PF. 1KV	DD-470	CRL	1500-04-7011	1	
C62T	CAP. CER. 82PF. 1KV	DD-820	CRL	1500-08-2011	1	
C47 C48	CAP. NICA. 100PF. 500V	DM15-101J	ARCO	1500-11-0100	2	
C57T	CAP. NICA. 150PF. 500V	DM15-151J	ARCO	1500-11-5100	1	
C15	CAP. NICA. 330PF. 500V	DM15-331J	ARCO	1500-13-3100	1	
C38T C39T	CAP. NICA. 56PF. 500V	DM15-560J	ARCO	1500-15-6000	2	
C46T C49T	CAP. NICA. 62PF. 500V	DM15-620J	ARCO	1500-16-2000	2	
C11	CAP. NICA. 820PF. 300V	DM15-821F	ARCO	1500-18-2101	1	
C40	CAP. 910PF. 100V. 1%	DM15-911F	ARCO	1500-19-1101	1	
WAVETEK PARTS LIST		TITLE MAIN		ASSEMBLY NO. 1100-00-0213		REV M
PAGE 2						

PAGE 2

REFERENCE DESIGNATORS	PART DESCRIPTION		
2	BKT. IC. 14 PIN		
3	BKT. IC. 16 PIN		
NONE	SOLDER LUG		
4	TERM		
NONE	TERM		
5	PIN. MALE		
6	STANDOFF 1.750 HEX4-40		
7	HEAT SINK		
8	TRANSIPAD		
R110	POT. CONT. 1K		
R20	POT. TRIM. 1K		
R40	POT. TRIM. 10K		
R116 R42	POT. TRIM. 100K		
R93	POT. TRIM. 200		
R141 R32 R72	POT. TRIM. 2K		
R113	POT. SWITCH. 10K		
WAVETEK PARTS LIST		TITLE MAIN	

A

NOTE: UNLESS OTHERWISE SPECIFIED

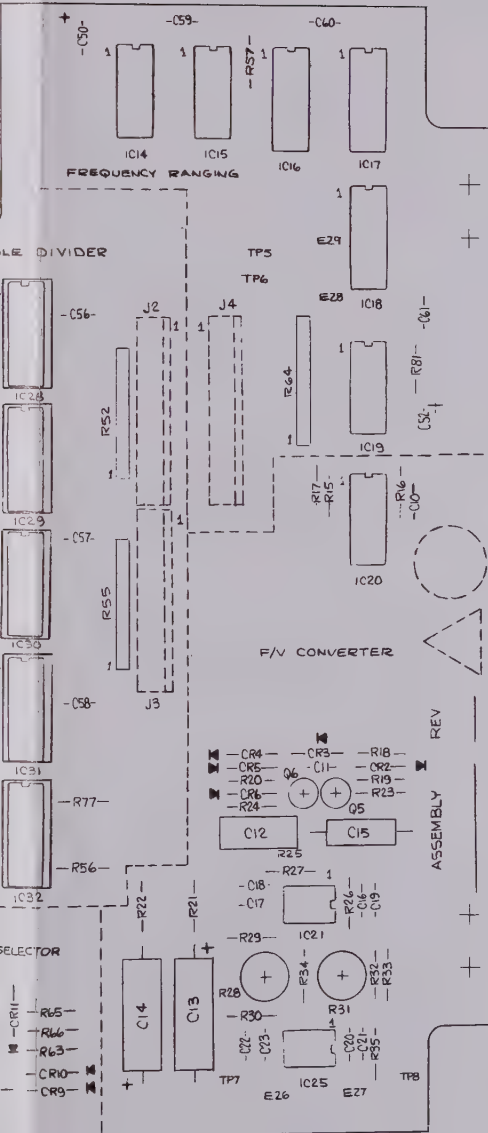
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												REV				ECN				BY				DATE				APP											
ORIG-MFGR-PART-NO				MFGR				WAVETEK NO.				QTY/PT				REFERENCE DESIGNATORS				PART DESCRIPTION				ORIG-MFGR-PART-NO				MFGR				WAVETEK NO.				QTY/PT			
6V 500010700016DC7				SPRAQ				1500-31-0101				7				R12 R131 R132 R24				RES. C. 1/2M. 5X. 10				RC-1/2-100J				STKPL				4700-25-0100				4			
35V 39D1080035QL6				SPRAQ				1500-31-0212				2				R34				RES. C. 1/2M. 5X. 3. 9				RC-1/2-3R9J				STKPL				4700-25-0399				1			
15V 39D1980015QL4				SPRAQ				1500-31-9201				1				R130 R133				RES. C. 1/2M. 5X. 43				RCR206430J8				AB				4700-25-0430				2			
25V 5RA25V822MC				UNCON				1500-32-2002				1				R43 R44 R47				RES. C. 1/2M. 5X. 1M				RC-1/2-105J				STKPL				4700-25-1004				3			
V 500050640050D7				SPRAQ				1500-33-0003				2				R122 R76 R8 R88				RES. MF. 1/8M. 1X. 100				RN550-1000F				TRW				4701-03-1000				4			
192P22292				SPRAQ				1500-42-2204				1				R104 R107 R15 R16 R26 R27 R46 R67 R80 R85				RES. MF. 1/8M. 1X. 1K				RN550-1001F				TRW				4701-03-1001				10			
192P22392				SPRAQ				1500-42-2304				3				R82				RES. MF. 1/8M. 1X. 10K				RN550-1002F				TRW				4701-03-1002				1			
OV 192P22498B				SPRAQ				1500-42-2403				1				R115 R36				RES. MF. 1/8M. 1X. 100K				RN550-1003F				TRW				4701-03-1003				2			
V 192P36392				SPRAQ				1500-45-6304				1				R138 R143				RES. MF. 1/8M. 1X. 10				RN550-1008F				TRW				4701-03-1009				2			
7B-TRIKO-Q2 3.5/13FF				TRIKO				1500-51-3000				1				R106 R137				RES. MF. 1/8M. 1X. 1.21K				RN550-1211F				TRW				4701-03-1211				2			
1500105X9035A2				SPRAQ				1500-71-0502				2				R102 R64 R71				RES. MF. 1/8M. 1X. 12. 1K				RN550-1212F				TRW				4701-03-1212				3			
1500106X9020B2				SPRAQ				1500-71-0601				3				R95				RES. MF. 1/8M. 1X. 124				RN550-1240F				TRW				4701-03-1240				1			
V 1500475X9035B2				SPRAQ				1500-74-7502				2				R7 R9				RES. MF. 1/8M. 1X. 13K				RN550-1302F				TRW				4701-03-1302				2			
ED 180-301				MVTK				1509-80-0008				1				R637 R69T				RES. MF. 1/8M. 1X. 1.37K				MEPCD				RN55013				4701-03-1371				2			
171-0213				MVTK				1700-00-0213				1				R128				RES. MF. 1/8M. 1X. 150				RN550-1500F				TRW				4701-03-1500				1			
SBA-20-B-T0				ROBNU				2100-03-0063				4				R10 R103 R108 R48 R75 R78				RES. MF. 1/8M. 1X. 1.5K				RN550-1501F				TRW				4701-03-1501				8			
ASSEMBLY NO. 1100-00-0213				REV W				WAVETEK PARTS LIST				TITLE W/IN				ASSEMBLY NO. 1100-00-0213				REV W																			
PAGE 3																PAGE 5																							

ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT	REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT						
D1LB14P/108	BURND	2100-03-0066	1	R87 R92	RES. MF. 1/8M. 1X. 15K	RN550-1502F	TRW	4701-03-1502	2						
D1LB14P-108	BURND	2100-03-0067	1	R33 R56	RES. MF. 1/8M. 1X. 165	RN550-1650F	TRW	4701-03-1650	2						
1497	SMITH	2100-04-0012	2	R98 R99	RES. MF. 1/8M. 1X. 17. 4K	RN550-1742F	TRW	4701-03-1742	1						
200081	USECO	2100-05-0009	13	R5	RES. MF. 1/8M. 1X. 1.78K	RN550-1781F	TRW	4701-03-1781	2						
201081	USECO	2100-05-0011	1	R83 R91	RES. MF. 1/8M. 1X. 19. 1K	RN550-1912F	TRW	4701-03-1912	2						
60809-2	AMP	2100-05-0020	2	R65 R68	RES. MF. 1/8M. 1X. 2K	RN550-2001F	TRW	4701-03-2001	4						
P-609-M03-F05-440	MVTK	2800-02-0016	4	R105 R121 R127 R37	RES. MF. 1/8M. 1X. 21. 5	RN550-21R5F	TRW	4701-03-2159	3						
207	WAKE	2800-11-0001	3	R126 R129 R136	RES. MF. 1/8M. 1X. 2.21K	RN550-2211F	TRW	4701-03-2211	1						
10160	METRS	2800-11-0004	2	R139	RES. MF. 1/8M. 1X. 237K	RN550-2373F	TRW	4701-03-2373	1						
180-401	MVTK	4600-01-0207	1	R70	RES. MF. 1/8M. 1X. 249	RN550-2490F	TRW	4701-03-2490	2						
91AR1K	BECK	4600-01-0209	1	R120 R96	RES. MF. 1/8M. 1X. 2.49K	RN550-2491F	TRW	4701-03-2491	4						
91AR10K	BECK	4600-01-0315	1	R38 R38 R81 R84	RES. MF. 1/8M. 1X. 24. 9K	RN550-2492F	TRW	4701-03-2492	3						
91AR100K	BECK	4600-01-0402	2	R124 R50 R55	RES. MF. 1/8M. 1X. 27. 4K	RN550-2742F	TRW	4701-03-2742	2						
91AR200	BECK	4600-02-0101	1	R140 R142	RES. MF. 1/8M. 1X. 3.01K	RN550-3011F	TRW	4701-03-3011	3						
91AR2K	BECK	4600-02-0201	3	R39 R77 R79	RES. MF. 1/8M. 1X. 30. 1K	RN550-3012F	TRW	4701-03-3012	2						
4602-01-0300	MVTK	4602-01-0300	1	R100 R97	RES. MF. 1/8M. 1X. 3.32K	RN550-3321F	TRW	4701-03-3321	1						
ASSEMBLY NO. 1100-00-0213				REV W				ASSEMBLY NO. 1100-00-0213				REV W			
PAGE 4				WAVETEK PARTS LIST				PAGE 6							

REMOVE ALL BURRS AND BREAK SHARP EDGES		DATE	WAVETEK SAN DIEGO - CALIFORNIA	
MATERIAL	PROCESSOR	TITLE		
RELEASE APPROV		PARTS LIST MAIN		
TOLERANCE UNLESS OTHERWISE SPECIFIED XXX - 0.10 ANGLES 1:1 XX - 0.05				
FINISH WAVETEK PROCESS	DO NOT SCALE DWG	MODEL NO	DWG NO	REV
SCALE		171	1100-00-0213	W
COST	23338	SHEET	1	OF 2



REV	ECN	BY	DATE	APP
E	ECN 1809	JRM	7-78	
F	ECN 2467	LOU	11-78	
G	3216	FW	1/85	OW
H	4770	KA	1/85	RET



WAVETEK
0101-00-0225 H
SYNTHESIZER BD.

P₁ 4-30-76
1 of 2
*NOTE (2 of 2 is "Q" SIZE)

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D

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-NFQR-PART-NO	NFQR	WAVETEK NO.	QTY/PT
NONE	ASSY DRWG. SYNTH	0101-00-0225	WVTK	0101-00-0225	1
NONE	SCHEMATIC. SYNTH	0103-00-0225	WVTK	0103-00-0225	1
NONE	BA PROC. SYNTH	0107-00-0225	WVTK	0107-00-0225	1
L1	TRANS. TORROID	3600-00-0011	WVTK	1204-00-0518	1
1	SPACER	144-306	WVTK	1400-00-2123	2
NONE	PLATE. BM	008-004	WVTK	1400-00-2130	1
2	SHIELD	171-5823	WVTK	1400-00-5823	1
C17 C18 C19 C21 C22 C23 C24 C29 C34 C38 C39 C4 C45 C53 C54 C55 C56 C57 C58 C59 C6 C60 C61 C62 C63 C64 C65 C66 C67 C7	CAP. CER. MN. .01MF. 50V	GE50-1031A	MURAT	1500-01-0310	30
C11 C41 C42	CAP. CER. MON. .1MF. 50V	CAC0323U1042050A	CORNG	1500-01-0405	3
C16 C20 C28 C33 C37	CAP. CER. 33PF. 1KV	BD-330 LONG LEAD	CRL	1500-03-3001	5
C9	CAP. MICA. 220PF. 500V	DM15-221J	ARCD	1500-12-2100	1
C3	CAP. MICA. 30PF. 500V	DM15-300J	ARCD	1500-13-0000	1
C2T	CAP. MICA. 47PF. 500V	DM15-470J	ARCD	1500-14-7000	1
C8	CAP. MICA. 56PF. 500V	DM15-560J	ARCD	1500-15-6000	1
C10 C26	CAP. 910PF. 100V. 5%	DM15-911J	ARCD	1500-19-1100	2
WAVETEK PARTS LIST	TITLE PCA. SYNTHESIZER	ASSEMBLY NO. 1100-00-0225	REV 9		

C

REFERENCE DESIGNATORS	PART DESCRIPTION
3	FERRITE BEAD
R28	POT. TRIM. 1K
R31	POT. TRIM. 2K
R58 R59	RES. C. 1/2W. 5%
R26 R41 R44 R47	RES. MF. 1/BM.
R63 R65 R66	RES. MF. 1/BM.
R16 R18 R20 R32 R35 R40T R56 R77	RES. MF. 1/BM.
R21 R22 R36 R49 R81	RES. MF. 1/BM.
R38	RES. MF. 1/BM.
R39	RES. MF. 1/BM.
R42 R43 R45 R46	RES. MF. 1/BM.
R29 R34	RES. MF. 1/BM.
R12 R13	RES. MF. 1/BM.
R1 R11 R14 R15 R17 R48 R5 R51 R53 R6 R7	RES. MF. 1/BM.
R50 R70 R9	RES. MF. 1/BM.
WAVETEK PARTS LIST	TITLE PCA. SYNTHESIZER

→

B

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-NFQR-PART-NO	NFQR	WAVETEK NO.	QTY/PT
C13 C14 C5	CAP. ELECT. 100MF. 16V	300D1070016DC7	SPRAG	1500-31-0101	3
C25 C44 C47 C48 C49 C50 C51 C52	CAP. ELECT. 22MF/25V	SRA25VB22MC	UNCON	1500-32-2002	8
C12 C31 C35	CAP. MYLAR. .1MF. 100V	225P10491M03	SPRAG	1500-41-0444	3
C15 C32 C36	POLYE. .022MF. 200V	192P22392	SPRAG	1500-42-2304	3
C1	VARI. 3. 5-13PF. 250V	78-TRIKO-02 3. 5/13PF	TRIKO	1500-51-3000	1
C27 C30 C40 C43 C46	CAP. TANT. .1MF. 35V	150D1059035A2	SPRAG	1500-71-0502	3
NONE	SYNTHESIZER BD	171-0225	WVTK	1700-00-0225	1
J1 J2 J3 J4	CONN. 9PIN	09-60-1091	MOLEX	2100-02-0052	4
C2TA C2TB	PIN SOCKET	SBA-20-S-T0	ROBNU	2100-03-0065	2
SKT6	SKT. IC. 16 PIN	D1LB14P/108	BURND	2100-03-0066	1
SKT1 SKT2 SKT3 SKT4 SKT5	SKT. IC. 16 PIN	D1LB16P-108	BURND	2100-03-0067	5
NONE	SOLDER LUG	1497	SHITH	2100-04-0012	1
3	PIN. MALE	60809-2	AMP	2100-05-0020	27
XTAL1	CRYSTAL. 4MHZ	180-502	WVTK	2300-99-0004	1
4	STANDOFF. 5/16" DIA. .625 H. 250 HEX-6-32. 062 MAT'L	15318-5/8	USECO	2800-02-0004	4
WAVETEK PARTS LIST	TITLE PCA. SYNTHESIZER	ASSEMBLY NO. 1100-00-0225	REV 9		

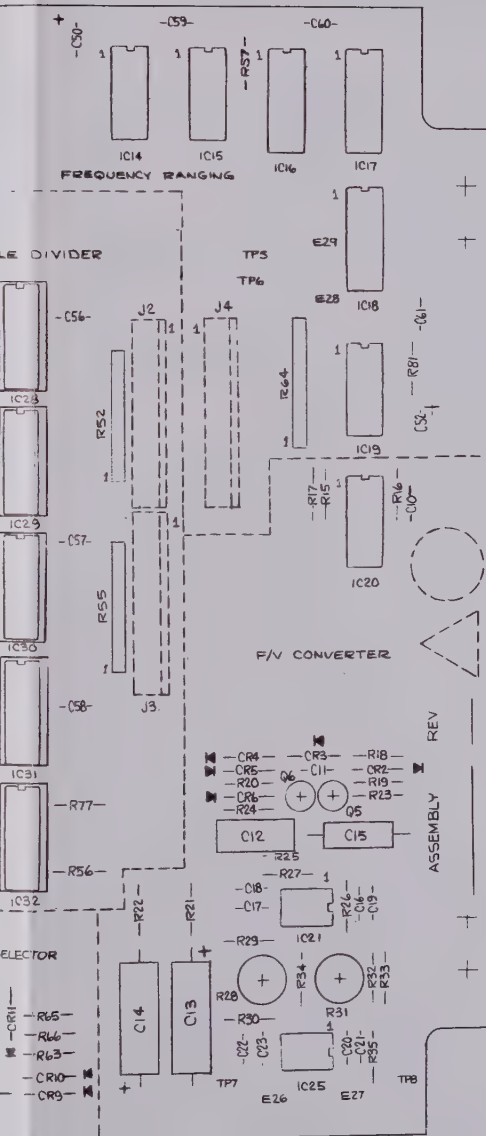
A

REFERENCE DESIGNATORS	PART DESCRIPTION
R23	RES. MF. 1/BM.
R24 R25	RES. MF. 1/BM.
R2	RES. MF. 1/BM.
R27 R30 R33	RES. MF. 1/BM.
R4	RES. MF. 1/BM.
R71 R75	RES. MF. 1/B.
R10 R19 R3 R57 R60 R61 R62 R72 R8	RES. MF. 1/BM.
R74	RES. MF. 1/BM.
R73	RES. MF. 1/BM.
R37T	RES. MF. 1/BM.
R68	RES. MF. 1/BM.
R69	RES. MF. 1/4W.
R67	RES. MF. 1/4W.
R76	RES. MF. 1/4W.
R52 R55 R64	RES. MODULE. 1
CR7	DIODE
WAVETEK PARTS LIST	TITLE PCA. SYNTHESIZER

NOTE: UNLESS OTHERWISE SPECIFIED

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REV ECN BY DATE APP											
D											
IN	DR10-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT	REFERENCE DESIGNATORS	PART DESCRIPTION	DR10-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT	
	56-590-65/38	FERRX	3100-00-0001	2	CR1 CR10 CR11 CR2 CR3 CR4 CR5 CR6 CR8 CR9	DIODE	1N4148	FAIR	4807-02-6666	10	
	91AR1A	BECK	4600-01-0209	1	02 03 04 06 08 09	TRANS	2N3903	NSC	4901-03-9030	6	
	91AR2A	BECK	4600-02-0201	1	03 07	TRANS	2N3905	ITT	4901-03-9030	2	
220	RC-1/2-221J	STKPL	4700-25-2200	2	01	TRANS	2N3485	MDT	4901-05-4850	1	
100	RM55D-1000F	TRW	4701-03-1000	4	5N1A 5N1B 5N1C	WAFER	142-5N1-1	WVTK	5104-02-0013	3	
1K	RM55D-1001F	TRW	4701-03-1001	3	NONE	SWITCH STOP	213-33-001-01-22	CTS	5104-07-0003	1	
10K	RM55D-1002F	TRW	4701-03-1002	8	5N1	MODIFIED DETENT FROM: 5104-01-0010	5104-99-0026	WVTK	5104-99-0026	1	
10	RM55D-10R0F	TRW	4701-03-1009	3	IC11 IC12 IC21 IC25	IC	LM 301AN	NSC	7000-03-0100	4	
13K	RM55D-1302F	TRW	4701-03-1302	1	IC10	IC	CA-3130	RCA	7000-31-3000	1	
1.5K	RM55D-1501F	TRW	4701-03-1501	1	IC16 IC17	IC	CD4518BE	RCA	8000-43-1810	2	
18.2K	RM55D-1822F	TRW	4701-03-1822	4	IC1 IC6	IC	74L800	TI	8000-74-0010	2	
2K	RM55D-2001F	TRW	4701-03-2001	2	IC26	IC	74LS02	TI	8000-74-0210	1	
20.5K	RM55D-2052F	TRW	4701-03-2052	2	IC22	IC	7410	TI	8000-74-1000	1	
2.21K	RM55D-2211F	TRW	4701-03-2211	11	IC19	IC	74LS10	TI	8000-74-1010	1	
249	RM55D-2490F	TRW	4701-03-2490	3	IC27	IC, DUAL D-TYPE FLIP-FLDP	74F74	FAIR	8000-74-7402	1	
ASSEMBLY NO. 1100-00-0225				REV Q	WAVETEK PARTS LIST		TITLE PCA, SYNTHESIZER		ASSEMBLY NO. 1100-00-0225		REV Q
PAGE 3							PAGE 5				
IN	DR10-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT	REFERENCE DESIGNATORS	PART DESCRIPTION	DR10-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT	
2.49K	RM55D-2491F	TRW	4701-03-2491	1	IC2 IC8	IC	74LS74	TI	8000-74-7410	2	
24.9K	RM55D-2492F	TRW	4701-03-2492	2	VR1	VOLTAGE REGULATOR	HA7805UC	FAIR	8000-78-0900	1	
301K	RM55D-3013F	TRW	4701-03-3013	1	IC20	IC	8601/9601	FAIR	8000-86-0100	1	
4.02K	RM55D-4021F	TRW	4701-03-4021	3	IC7	IC	96L02	FAIR	8000-96-0210	1	
47.5K	RM55D-4752F	TRW	4701-03-4752	1	IC18	IC	74LS151	TI	8007-41-5110	1	
499	RM55D-4990F	TRW	4701-03-4990	2	IC24	IC, 8-INPUT MULTIPLEX	74F151	TI	8007-41-5120	1	
4.99K	RM55D-4991F	TRW	4701-03-4991	9	IC29 IC30 IC31 IC32	IC	74LS192	TI	8007-41-9210	4	
56.2	RM55D-56R2F	TRW	4701-03-5629	1	IC28	COUNTER, UP/DOWN, BCD 16 PIN DIP	74F192PC	FAIR	8007-41-9211	1	
61.9	RM55D-61R9F	TRW	4701-03-6199	1	IC14 IC15 IC3 IC4 IC5	IC	74LS290	TI	8007-42-9010	3	
6.23K	RM55D-6251F	TRW	4701-03-6251	1	IC23	IC	74LS293	TI	8007-42-9310	1	
909	RM55D-9090F	TRW	4701-03-9090	1	IC13	IC	MC1648P	MDT	8100-16-4810	1	
121	RM60D-1210F	TRW	4701-13-1210	1	IC9	IC	MC4044P	MDT	8100-40-4400	1	
124	RM60D-1240F	TRW	4701-13-1240	1							
49.9	RM60D-49R9F	TRW	4701-13-4999	1							
	4310R-101-103	BOURN	4770-00-0008	3							
	HV1404	MDT	4803-02-1404	1							
ASSEMBLY NO. 1100-00-0225				REV Q	WAVETEK PARTS LIST		TITLE PCA, SYNTHESIZER		ASSEMBLY NO. 1100-00-0225		REV Q
PAGE 4							PAGE 6				
REMOVE ALL BURRS AND BREAK SHARP EDGES				DRAWN		DATE		WAVETEK SAN DIEGO • CALIFORNIA			
MATERIAL				PROVENOR		RELEASE APPROV		TITLE PARTS LIST PCA, SYNTHESIZER			
FINISH WAVETEK PROCESS				TOLERANCE UNLESS OTHERWISE SPECIFIED XX : 010 ANGLES 11 X2 : 030		DO NOT SCALE DWG		MODEL NO. 171		DWG NO. 1100-00-0225	
SCALE				CODE 23338		SHEET 1		REV Q		OF 1	
4	3	2	1								

REV	ECN	BY	DATE	APP
E	ECN 1809	JRM	9-19-8	
F	ECN 2467	LOU	11-4-8	
G	3216	RA	12/11/8	MC
H	4770	RA	1/1/85	CT



WAVETEK
0101-00-0225 H
SYNTHESIZER BD.

P. 4-30-76
1 of 2
*NOTE (1 of 2 is "B" SIZE)

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NOTE: UNLESS OTHERWISE SPECIFIED

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REV ECH BY DATE APP

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REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFR-PART-NO	MFR	WAVETEX NO.	QTY/PT
C1 C2 C3	CAP. CER. MON. .1MF. 50V	CAC0325U104Z050A	CORNG	1500-01-0405	3
RA0	POT. TRIM. 10K	91AR10K	BECK	4600-01-0315	1
R6 R7 R9	RES. MF. 1/8W. 1%. 1K	RN55D-1001F	TRW	4701-03-1001	3
R8	RES. MF. 1/8W. 1%. 2.21K	RN55D-2211F	TRW	4701-03-2211	1
R4 R5	RES. MF. 1/8W. 1%. 3.01K	RN55D-3011F	TRW	4701-03-3011	2
R2 R3	RES. MF. 1/8W. 1%. 7.5K	RN55D-7501F	TRW	4701-03-7501	2
CR2	DIODE. ZENER. 6.8V	1N754A	MOT	4801-01-0734	1
CR1	DIODE	1N4148	FAIR	4807-02-6666	1
Q1	TRANS	2N3904	FAIR	4901-03-9040	1
	TRANS	2N4122	NBC	4901-04-1220	1
Q3	TRANS	2N5485	MOT	4901-05-4850	1
U1	IC. OP-AMP	LF354N	NBC	7000-03-5600	1
TITLE		ASSEMBLY NO. 1208-00-2252			REV
BPK ASSY. PIGGYBACK BOARD		PAGE 1			
WAVETEK PARTS LIST					

REMOVE ALL BURRS AND BREAK SHARP EDGES		DATE	WAVETEK SAN DIEGO • CALIFORNIA		
MATERIAL	DESIGNER		TITLE PARTS LIST PCA, PIGGYBACK BOARD		
	RELEASE APPROV				
	TOLERANCE UNLESS OTHERWISE SPECIFIED XXX : .010 ANGLES : 1 XX : .005				
FINISH WAVETEK PROCESS	DO NOT SCALE DWG		MODEL NO 171	DWG NO 1208-00-2252	REV A
	SCALE				
			CODE 23330 SHEET 1 OF 1		

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